Expert Report of Professor David Cutler

March 25, 2019

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I. Qualifications

1. My name is David Cutler. I am the Otto Eckstein Professor of Applied Economics and Harvard College Professor at Harvard University. I have appointments in the Department of Economics, the Harvard Kennedy School, and the Harvard T.H. Chan School of Public Health. I have been on the faculty at Harvard for over 25 years. I received a Ph. D. in Economics from the Massachusetts Institute of Technology in 1991 and an A.B. from Harvard University in 1987.

2. I specialize in Health Economics and Public Economics. I have published more than 200 articles and have written two books on the economics of heath care. I am a former editor of the Journal of Health Economics and a former Associate Editor of the Journal of Economic Perspectives, the Journal of Public Economics, and the World Health Organization Bulletin.

3. I have won a variety of awards for my scholarship including the Griliches Prize in 1999, the Ken Arrow Award from the International Health Economics Association for best paper in health economics in 2000, the Eugene Garfield Award from Research!America in 2003, the David Kershaw Prize from Association for Public Policy and Management in 2004, the Biennial award for distinguished contribution to the literature in population from the Section on the Sociology of Population of the American Sociological Association in 2006, the John P. McGovern Award from the Association of Academic Health Centers in 2009, the Distinguished Leadership Award from the Center for Connected Health in 2011, the MetLife Silver Scholar Award from the Alliance for Aging Research in 2011, and the Carpenter Award from Babson College in 2018. Along with Jonathan Gruber, I won the ASHEcon award for best health economist in the nation age 40 and under in 2006. I am a member of the American Academy of Arts and Sciences and the National Academy of Medicine. I was named one of the "30 for the Future" by Modern

Healthcare magazine in 2006 and one of the "50 most influential men under age 45" by Details magazine in 2007. An article in 2012 listed me as the health economist with the highest h-index in the world.[1] The h-index is a widely used measure of scholarly productivity and citation frequency.

4. In addition to my scholarly activities, I have a record of service in the public sector. I served jointly on the Council of Economic Advisors and National Economic Council in 1993, with primary responsibility for health care. I have been a Commissioner for the Health Policy Commission in Massachusetts since 2012. As part of its responsibilities, the Commission extensively studied the impact of opioid use on the health of citizens and the cost of medical care in Massachusetts and has sponsored programs to reduce the impact of opioids.

5. I have written extensively on issues related to population health. In a number of research papers, I have sought to understand how and why population health changes over time. This includes measures of fatal and non-fatal health and behavioral and economic contributors to these trends. Included in this writing are several papers on addictive goods, including analyses of smoking, obesity, and other addictive behaviors.[2]

[1] Wagstaff, Adam and Anthony J. Culyer. "Four decades of health economics through a bibliometric lens." *Journal of Heath Economics* 31 (2012): 406-439, Table 5.

[2] Cutler, David M. and Susan T. Stewart. "The Contribution of Behavior Change and Public Health to Improved US Population Health." Review of Behavioral and Social Sciences Research Opportunities: Innovations in Population Health Metrics. AHRQ Publication. 2015. 15(002); Cutler, David, Angus Deaton, and Adriana Lleras-Muney. "The Determinants of Mortality." *The Journal of Economic Perspectives* 20 (2006): 97-120.; Cutler, David M., Edward L. Glaeser, and Jesse M. Shapiro. "Why Have Americans Become More Obese?" *The Journal of Economic Perspectives* 17 (2003): 93-118.; Cutler, David M., Amber I. Jessup, Donald S. Kenkel, and Martha A. Starr. "Economic Approaches to Estimating Benefits of Regulations Affecting Addictive Goods." *American Journal of Preventative Medicine* 50 (2016): S20-S26.

6. My curriculum vitae, which provides additional detail about my career and publications is attached as **Appendix III.A**. My billing rate in the matter is $900 per hour. My compensation is not dependent on the outcome of this proceeding. My analysis is ongoing, and I reserve the right to supplement or modify it based on new materials or testimony that may become available to me, including, but not limited to, other expert witness reports that have not been produced prior to the completion of my assignment.

II. Assignment and Summary of Conclusions

7. This litigation, brought by Cuyahoga County and Summit County (collectively referred to herein as the "Bellwether governments" or "Bellwether jurisdictions" or "Bellwether plaintiffs"), alleges among other things that the defendant manufacturers' conduct in "promoting opioid use, addiction, abuse, overdose and death has had severe and far-reaching public health, social services, and criminal justice consequences, including the fueling of addiction and overdose from illicit drugs such as heroin."[3] The governments further allege that the opioid epidemic and the need for increased services, "arose from the opioid manufacturers' deliberately deceptive marketing strategy to expand opioid use, together with the distributors' equally deliberate efforts to evade restrictions on opioid distribution."[4] In addition, the Bellwether plaintiffs allege "the crisis was fueled and sustained by those involved in the supply chain of opioids, including manufacturers, distributors, and pharmacies . . . who failed to

[3] In Re National Prescription Opiate Litigation, The County of Cuyahoga, Ohio, et al., v. Purdue Pharma L.P., et al., Case No. 17-OP-45004, Second Amended Complaint, May 18, 2018, ("Cuyahoga Complaint"), ¶19; In Re National Prescription Opiate Litigation, The County of Summit, Ohio, et al., v. Purdue Pharma L.P., et al., Case No. 17-md-2804, Corrected Second Amended Complaint, May 18, 2018, ("Summit Complaint"), ¶20.

[4] Cuyahoga Complaint, ¶3; Summit Complaint ¶3.

maintain effective controls over the distribution of prescription opioids, and who instead have actively sought to evade such controls . . . thereby exacerbating the oversupply of such drugs and fueling an illegal secondary market."[5] I refer to these actions collectively as "defendants' misconduct." I also refer to the adverse health, public health, public welfare and criminal justice consequences of the opioid epidemic as "harms."

8. An analysis of damages incurred by the Bellwether jurisdictions due to defendants' misconduct requires an evaluation of the impact of prescription opioid shipments on harms that impose costs on Bellwether jurisdictions. As part of this analysis I also review how shipments of prescription opioids ultimately resulted in harms stemming from illicit opioids. The costs imposed on the Bellwethers from these harms are addressed in the Expert Report of Prof. Thomas McGuire (the "McGuire Report").[6] To be clear, for purposes of this report, the impact of prescription opioid shipments on harms to the Bellwethers includes all of defendants' misconduct I described above, including all defendants who used or endorsed deceptive marketing strategies and all defendants who failed to maintain effective controls over the distribution of prescription opioids.

9. My analysis yields annual estimates of the share of various harms imposed on selected departments in each Bellwether government ("Bellwether divisions") that is attributable to

[5] Cuyahoga Complaint, ¶14, Summit Complaint, ¶14.

[6] Because aspects of analyses presented in the report are related to analysis included in the Expert Report of Professor Jonathan Gruber ("Gruber Report"), the Expert Report of Professor Meredith Rosenthal ("Rosenthal Report") and the Expert Report of Professor Thomas McGuire ("McGuire Report"), the following numbering convention is adopted to identify tables, appendices and back up materials from each report: Materials related to this report are identified with the prefix III (e.g., Table III.1); materials related to the Gruber Report use the prefix I; materials related to the Rosenthal Report use the prefix II; and materials related to the McGuire report use the prefix IV.

defendants' misconduct. The analysis incorporates two alternative estimates of the share of prescription opioid shipments that are attributable to misleading marketing, which are set forth in the Expert Report of Prof. Meredith Rosenthal (the "Rosenthal Report").[7] An alternative version of my analysis reported in Appendix III.J to this report incorporates an estimate of the share of prescription opioids that should have been identified as suspicious by distributors.[8]

10. My assignment in this report thus is to evaluate the following issues identified by counsel and to answer the following questions framed by counsel:

What was the effect of prescription opioid shipments on harms that resulted in county costs?

1) *For each administrative division for which one or more of the Bellwether governments seeks recovery, did the increase of prescription opioid shipments since 1995 contribute to harms that result in costs faced by the relevant divisions?*

2) *What is the size of these effects? For each administrative division, calculate the percentage of harm attributable to prescription opioid shipments in each year 2006-2018 for each of the Bellwether governments.*

3) *For each administrative division for which either Bellwether government seeks recovery, what is the percentage of harm attributable to prescription opioid shipments for which defendants are responsible in each year 2006-2018 for each Bellwether government?*

4) *Provide the economic rationale for your estimates.*

[7] Prof. Rosenthal presents estimates of the share of prescription opioid shipments due to defendants' misconduct using (1) a direct shipments regression method; and (2) an indirect shipments regression method. Section VI of this report incorporates the estimates from the direct regression method. Appendix III.K presents an analysis of the percent of harms due to defendants' misconduct based on the indirect regression method.

[8] I understand certain expert reports related to distributor misconduct are not being disclosed until April 15, 2019. Appendix III.J contains inputs that will also be set forth in reports that will be disclosed that day. As set forth above, I reserve the right to modify this analysis based on filed version of those reports.

11. With respect to the questions posed by counsel, I reach the following conclusions:

1) The increase in prescription opioid shipments since 1995 has contributed to harms that the relevant divisions of the Bellwether governments provide services to address;

2) The percentage of harms attributable to prescription opioid shipments can be economically estimated;

3) My analysis of the percentage of harms attributable to prescription opioid shipments, together with analysis of the percentage of prescription opioid shipments that are due to the defendants' misconduct reported in the Rosenthal Report, yields annual estimates of the percentage of harms due to defendants' misconduct for each Bellwether division affected by the opioid crisis;

4) My analysis of the percentage of costs attributable to prescription opioid shipments is confirmed by a supplementary analysis of the direct effect of prescription opioid shipments on crime;

5) My methodology for computing annual estimates of the percentage of harms due to the defendants' misconduct would not be modified if the inputs are varied, so that if different percentages are assigned to the shipments attributable to the defendants' misconduct, the methodology can still be applied in estimating damages based on the modified calculations.

12. In preparing this report, I and staff under my direction: analyzed data; reviewed economic literature, court filings, documents produced in this litigation, and deposition testimony. A list of materials that I have considered is attached as **Appendix III.B**. The analytical and econometric methods used in this report reflect commonly established principles and techniques used in the field of health economics. Detailed discussions of each of these methods, the mechanics of the empirical estimation, their applicability, and usage in the academic literature can be found in Sections III through V below.

13. Health economics is a well-recognized subfield of economics which provides an appropriate framework for analyzing the sources and impact of the opioid crisis. There are

national and international organizations devoted to the study of health economics, such as the American Society of Health Economists (ASHEcon) and the International Health Economics Association (IHEA).[9] There are also numerous conferences devoted to health economics, several journals in the field (e.g. Journal of Health Economics, Health Affairs), textbooks on the topics, and courses on health economics taught at a large number of universities in the US and abroad.

14. Within the field of health economics, a major focus of study has been understanding markets for products with health risks. This includes analysis of tobacco use, alcohol intake, excessive food consumption, and, more recently, excessive use of opioids. In analyzing these topics, scholars have evaluated and published research on issues such as what actions on the part of corporations lead to excessive use of these substances and how excessive use of substances affects public budgets. The field also has extensive experience understanding how use of substances is related to personal harms such as mortality and morbidity. Specific studies on the harms of opioids are referred to later in this report. These studies, which build off decades of work by health economists, are authored by academics, private researchers and government agencies and are widely used in setting policy.

15. The remainder of this report is organized as follows:

- Section III presents an overview of the framework used to calculate the percentage of harms incurred by the Bellwether divisions that is attributable to prescription opioid shipments.
- Section IV presents estimates of the share of various harms faced by Bellwether jurisdictions that is due to opioids.

[9] https://www.ashecon.org/; https://www.healtheconomics.org/.

- Section V presents alternative approaches to estimating the impact of shipments of prescription opioids on mortality.
- Section VI summarizes estimates of mortality that can be attributed to defendants' misconduct, which incorporate estimates from the Rosenthal Report on the effect of defendants' misconduct on prescription opioid shipments.
- Section VII presents estimates of the share of various opioid-related harms faced by Bellwethers that are attributable to defendants' misconduct.
- Section VIII presents a supplemental analysis of the impact of opioids on crime.

III. Framework for Evaluating the Effect of Prescription Opioid Shipments on Harms that Imposed Costs on Bellwether Governments

16. As the review of the opioid crisis in the Gruber Report shows, it is widely recognized that the opioid crisis has resulted in a variety of social harms including increased mortality from both prescription and illicit opioids, increased trafficking in heroin and other illicit opioids, and increased demand for police services, criminal justice services, addiction treatment services, services for children and families, and first responder services, among other harms.

17. Analysis of the link between opioid shipments and harms is complicated by features of the opioid marketplace which make it unique among pharmaceuticals.[10] First, there is a substantial set of illegal opioids which are closely related chemically to legal opioids. For example, heroin and synthetic fentanyl are close chemical analogues to the active substances in legal opioids.[11] Available evidence indicates that licit and illicit opioids are to some degree substitutes. The analysis thus needs to explicitly consider harms due to any use of illicit opioids that resulted from defendants' actions along with harms due to licit opioids. The analysis also

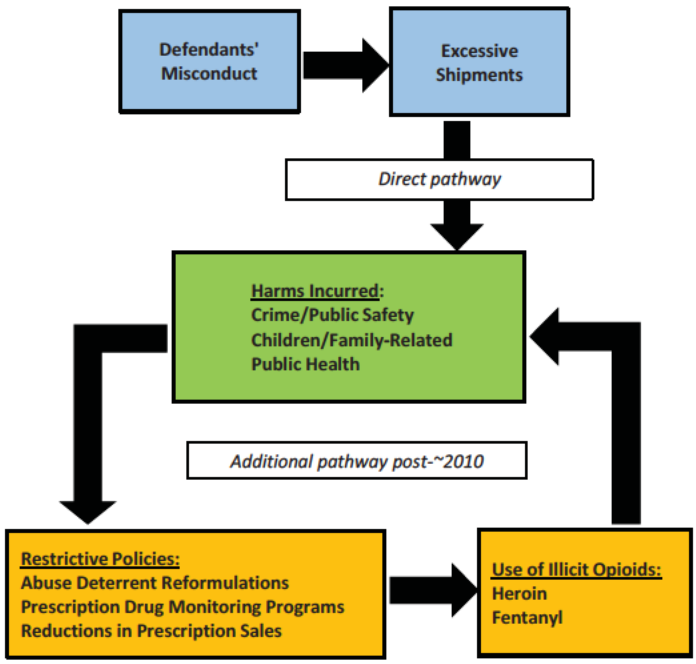
[10] See Gruber Report for additional discussion.

[11] See, for example, Kosten, Thomas R., and Tony P. George. "The neurobiology of opioid dependence: implications for treatment." *Science & Practice Perspectives* 13 (2002): 13-20. I understand this is also addressed in the Expert Report of Dr. Katherine Keyes.

needs to account for the consequences of public and private policy interventions that decreased the availability of some licit opioid products which, in turn, led people to turn to illicit, more harmful, opioids. Each of these factors influences the nature of the empirical analysis.

18. The approach that is used here for estimating harms is depicted in **Figure III.1** below. defendants' misconduct is shown in the blue boxes in the upper part of the figure. This conduct includes, but is not limited to, the misrepresentations of the risks and benefits of opioid therapy by manufacturer defendants and the failure to detect and prevent excessive opioid shipments by all registrants of the Controlled Substances Act ("CSA"), including the distributor defendants. For the purposes of my analysis, I assume defendants' misconduct directly influences sales and shipments of prescription opioids, as presented in the Rosenthal Report. Excessive use of prescription opioids, in turn, leads to the variety of harms noted above: law enforcement, courts, child-related, and public health problems. The policy response to these problems played out on a number of levels, including: federal, state, and local policy; policy changes by private and public insurers; recommendations and restrictions implemented by medical societies and health care organizations; and changes by pharmaceutical companies. Together, these various policies contributed to increased use of illicit opioids and further harms, none of which would have been expected to occur in the absence of defendants' actions.

Figure III.1
Relationship Between Opioid Sales and Harms



19. The divisions in each of the Bellwether governments that have been affected by increased costs resulting from these harms are identified in the McGuire Report and are shown in **Table III.1** below, categorized based on the types of services these divisions provide to their jurisdictions.

20. For the purpose of evaluating opioid-related harms that impose costs on Bellwether governments, the analysis considers the impact of defendants' action on the following categories of harm: criminal activity that imposes costs on Bellwether divisions that provide police and public safety services; the demand for services related to children and families that imposes costs on Bellwether divisions responsible for children and family services; the demand for addiction treatment services funded by Bellwether governments; and the demand for services by medical examiners (coroners), which are also provided by Bellwether governments.

The framework of these applications is discussed in this section and the implementation and results of these calculations are presented in the following sections below.

Table III.1
Delineation of Services That are Affected by the Opioid Epidemic

Type of Harm	Counties (Cuyahoga/Summit)
Crime/Public Safety	Sheriff Juvenile and County courts Prosecutor and Public Defenders' Office Corrections
Children/Family Related	Children and Family Services / Children Services Board
Public Health	Alcohol/Drug/Mental Health Boards Medical Examiners' Office

A. Overview of General Framework

21. This section describes and motivates the general framework used to estimate harms caused by opioid shipments that result from defendants' misconduct. This framework requires three component calculations:

- The percentage of harms that is attributable to opioids;
- The percentage of opioid-related harms that is attributable to shipments of prescription opioids; and
- The percentage of shipment-related harms that is attributable to defendants' misconduct.

22. This general framework is applied in evaluating each of the harms that have imposed costs on selected divisions of the Bellwether governments. Together, these components yield estimates of the share of various harms that are attributable to shipments resulting from defendants' misconduct.

23. This approach can be summarized by the multiplication of the three components, as summarized in the following equation:[12]

$$\begin{aligned} &Share\ of\ Harms\ Attributable\ to\ Defendants'\ Misconduct \\ &= \ Share\ of\ Harms\ Attributable\ to\ Opioids \\ &\quad x\ Share\ of\ Opioid\ Harms\ Attributable\ to\ Opioid\ Shipments \\ &\quad x\ Share\ of Opioid\ Shipments\ Due\ to\ Defendants' Misconduct \end{aligned}$$

B. Share of Harms Attributable to Opioids

24. The first step in implementing this framework requires estimating the share of various harms attributable to opioids, including those related to both prescription opioids and illicit opioids. This first step can itself include multiple parts, and for several categories of harm requires estimating (i) the share of harms that are due to drug use in general (including both opioids and non-opioids) and (ii) the share of these drug-related harms that are attributable to opioids. More specifically, for many types of harm the calculation is:

$$\begin{aligned} &Share\ of\ Harms\ Attributable\ to\ Opioids \\ &= \ Share\ of Harms\ Attributable\ to\ Drugs \\ &\quad x\ Share\ of\ Drug\ Harms\ Attributable\ to\ Opioids \end{aligned}$$

In some instances, however, data are available that allow direct estimation of the percentage of harms due to opioids in a single calculation.[13]

25. The data and precise method used to estimate the share of harms attributable to opioid misuse in this first step vary by type of harm and are discussed in more detail below. This

[12] This formulation accurately summarizes the steps of the calculation. As discussed further below, implementation of the approach to develop year-specific estimates involves more complex calculations.

[13] For example, the Cuyahoga Medical Examiner's office provides data directly on opioid-related overdoses.

general approach for estimating the share of harms that are due to opioids has been extensively used in scientific literature for evaluating the costs attributable to the opioid epidemic, including for example in CEA (2017), Florence, et al. (2016), Birnbaum et al. (2011), Hansen et al. (2011), and Birnbaum et al. (2006).[14]

C. Share of Harms Attributable to Opioid Shipments

26. The second step of the analysis requires an estimate of the share of opioid-related harms that is attributable to shipments of prescription opioids, as opposed to opioid-related harms that would have occurred even in the absence of shipments of prescription opioids. For this analysis, opioid-related mortality is used as a proxy for opioid-related harms and the share of opioid-related mortality which is attributable to shipments of prescription opioids is estimated. Two different statistical methods are used in estimating this element of the calculation.

- The first method is based on regression estimates of the relationship between changes over time in opioid mortality across different geographic areas and shipments of prescription opioids in those areas. This regression is used to estimate the elevation in opioid-related mortality due to shipments of prescription opioids. This is referred to as

[14] Council of Economic Advisors. "The Underestimated Cost of the Opioid Crisis." (2017); Florence, Curtis S., Chao Zhou, Feijun Luo, and Likang Xu. "The economic burden of prescription opioid overdose, abuse, and dependence in the United States, 2013." *Medical Care* 54 (2016): 901-906 (Florence et al (2016)); Birnbaum, Howard G., Alan G. White, Matt Schiller, Tracy Waldman, Jody M. Cleveland, and Carl L. Roland. "Societal costs of prescription opioid abuse, dependence, and misuse in the United States." *Pain Medicine* 12 (2011): 657-667 (Birnbaum et al (2011)); Hansen, Ryan N., Gerry Oster, John Edelsberg, George E. Woody, and Sean D. Sullivan. "Economic costs of nonmedical use of prescription opioids." The Clinical Journal of Pain 27 (2011): 194-202 (Hansen et al (2011)); Birnbaum, Howard G., Alan G. White, Jennifer L. Reynolds, Paul E. Greenberg, Mingliang Zhang, Sue Vallow, Jeff R. Schein, Nathaniel P. Katz. "Estimated costs of prescription opioid analgesic abuse in the United States in 2001: a societal perspective." *The Clinical Journal of Pain* 22 (2006): 667-676 (Birnbaum et al (2006)).

the "direct approach" because it specifically seeks to directly model the causal effect of shipments on mortality. As discussed further below, regression models of this type are commonly used in economic analysis.

- The second method is based on a regression analysis of the relationship between opioid mortality across geographic areas and the economic and demographic characteristics of those areas in a "base period" that, in principle, precedes defendants' misconduct alleged in this case. This base period regression is then used to predict opioid mortality rates that would have been expected due to changes in economic and demographic factors in the absence of defendants' misconduct. The resulting difference between actual and "but for" opioid-related mortality yields an alternative estimate of the impact of shipments of prescription opioids on opioid-related mortality. This is referred to as the "indirect approach." As discussed further below, analysis of the impact of economic events using an "indirect" approach of this type is common in economic analysis.

27. The motivation for the choice of and applications of these statistical analyses are discussed in more detail in Section V below. Combining the results of the first two steps of these calculations – the share of harms faced by Bellwether governments attributable to opioids and the share of opioid-related harms attributable to shipments of prescription opioids – yields an estimate of the share of various harms that are attributable to prescription opioid shipments.

D. Share of Opioid Shipments Attributable to Defendants' Misconduct

28. The third step in the analysis is to incorporate estimates of the share of the opioid-related shipments that are attributable to defendants' collective misconduct. If all shipments of opioids were the result of misconduct, then there would be no difference between estimates of the harm attributable to opioid shipments and harm attributable to shipments that resulted from misconduct by defendants. Professor Rosenthal reports year-specific estimates of the extent to which shipments of prescription opioids resulted from defendants' marketing misconduct which indicate that most, but not all, shipments are attributable to defendants' marketing misconduct.

E. Attribution of Harm Across Multiple Responsible Parties

29. The methodology laid out here yields an estimate of the share of various harms in Bellwether jurisdictions that stem from misleading marketing of prescription opioids as calculated in the Rosenthal Report. However, this does not mean that improper marketing is solely responsible for these harms. I have been instructed to assume that all registrants of the CSA including distributors of prescription opioids have legal obligations to maintain effective controls against diversion, including to identify excessive shipments and to prevent such shipments and report them to the appropriate regulatory authorities. The Bellwether complaints claim that defendants' failure to control the supply chain and their "deliberate efforts to evade restriction on opioid distribution" was a contributing factor to the opioid epidemic.[15]

[15] Cuyahoga Complaint, ¶3, Summit Complaint ¶3.

30. Analysis presented in the Gruber Report establishes wide variation in per capita shipments across counties after controlling for demographic differences in population characteristics. This indicates that many shipments were both excessive and were not identified and prevented by CSA registrants, including distributors. This in turn implies that some harms, and thus damages to Bellwether governments, could have been avoided if these defendants had acted properly.

31. The analysis presented here does not attempt to uniquely apportion harm resulting from actions by any individual type of defendant. In some circumstances when multiple parties contribute to the same indivisible harms, it is unlikely that a unique attribution of harm to each contributing party is possible. This report first presents estimates of harm that stem from the elevation in shipments resulting from marketing misconduct. However, as noted, such harms cannot be solely attributable to manufacturers since some harm could have been prevented had all registrants of the CSA, including distributors, met their legal obligations. **Appendix III.J** shows how the framework for estimating harm developed in this report can be applied to estimate harms that could have been avoided in the absence of supply-chain misconduct by CSA registrants including distributors.

IV. Estimation of the Share of Harms Attributable to Opioids

32. This section discusses implementation of the first step of the analysis – estimation of the share of various harms faced by Bellwether governments that are attributable to opioids. The

section describes the key elements of the calculations and the data that underlies these calculations for each of the harms that impose costs on the Bellwether governments.

33. As noted, for most harms, the calculation of the share that is attributable to opioids itself involves two distinct steps: (i) estimation of the percent of harms due to drug use as a whole and (ii) estimation of the percent of drug activity due to opioids. These two components are then multiplied to yield an estimate of the share of harms that are attributable to opioids. A brief description of these calculations is presented below for each of the different categories of harm. The full details of the data and calculations are presented in the **Appendices III.C through III.G** attached to this report.

A. Share of Crime Attributable to Opioids

34. The share of criminal activity attributed to opioids is used to estimate opioid-related costs across Bellwether divisions with responsibilities that include policing, courts and adjudication, and corrections. Therefore, while the general estimation method is the same across these divisions (or types of activities), the data used in the calculation can vary by division and Bellwether depending on activity and data availability. Descriptions of the methodology and data used are provided below, including discussions of differences, when relevant, across divisions and Bellwether governments.[16]

35. To measure the share of crime due to opioids, data are utilized on criminal activity for each Bellwether and crime-related division.[17] These data provide information on the total

[16] As referenced above, this methodology (and many of the data sources used in the estimation) follow the literature of Florence, et al. (2016), Birnbaum et al. (2011), and Birnbaum et al. (2006).
[17] Criminal activity is measured as crime offenses, criminal bookings, or criminal charges depending on the data source listed in Table III.2.

amount of criminal activity as well as the distribution of the type of crime (e.g. murder, burglary, motor vehicle theft, etc.) across the relevant crime measure. **Table III.2** below reports the source of data for each of the Bellwether divisions for these crime counts.

Table III.2
Sources of Crime Incident Data by Bellwether and Division

Bellwether	Division	Source of Crime Incident Counts
Cuyahoga	Prosecutor / Public Defender / Court of Common Pleas / Sheriff / Jail / Juvenile Court	Cuyahoga Prosecutor Database (2009 - 2017)
Summit	Prosecutor / Court of Common Pleas / Sheriff / Adult Probation / Juvenile Court	NIBRS
	Sheriff Jail / Alternative Corrections	Bureau of Justice Statistics - Prisoner Statistics

36. The FBI's National Incident-Based Reporting System (NIBRS) data provide information on the number and type of criminal offenses that occurred within the jurisdiction of the Sheriff division in Summit County.[18] These data are used to estimate criminal activity for the Sheriff division that provides policing services as well as for divisions that provide court and adjudication services in Summit, as this kind of data for these other divisions were not available (as indicated in **Table III.2** above). Because NIBRS data are not available for Cuyahoga County, the estimates for criminal activity in Cuyahoga's divisions are calculated from data provided by the Cuyahoga County Prosecutors Office on criminal charges. These data provide the number of criminal charges, the FBI Uniform Crime Reporting category for each of these charges, and an indication as to whether or not the charged individual was a juvenile.

37. For the Summit County correctional services, the measure of criminal activity is derived from Bureau of Justice Statistics data on the distribution of crime across inmates in the Ohio

[18] https://ucr.fbi.gov/nibrs-overview.

state prison system. Finally, estimates for the juvenile court divisions in both Summit and Cuyahoga rely on data reporting the distribution of criminal activity in that area, as well as data on child removals (discussed in more detail below in Section IV.C), as these courts handle both criminal cases involving juveniles, as well as cases involving children removed from homes.

38. Using the data described above, the next step in the analysis is to then determine the share of these crimes that were either directly or indirectly motivated by drugs. This calculation relies on the reported percentages of different crime categories that are committed for drug-related reasons, as estimated in a study published by the National Drug Intelligence Center (NDIC) of the U.S. Department of Justice in 2011.[19] These estimates, which are based on interviews of prisoners, attempt to identify the circumstances surrounding arrests. Drug crimes are defined to include those involving the purchase or sale of illicit drugs as well as estimates of the share of other crimes undertaken to obtain drugs or to obtain money to purchase drugs. NDIC also counts a small portion of crimes undertaken while on drugs as drug-related.[20] The specific shares of crimes due to drug use are shown in **Table III.3** below. These drug-related shares are applied to the crime counts in each of the Bellwethers in each year to calculate a share of total crime in each year that is drug-related.[21]

[19] US DOJ National Drug Intelligence Center, "The Economic Impact of Illicit Drug Use on American Society" (2011) (NDIC (2011)), Table 1.7.

[20] NDIC counts only 10 percent of crimes committed under the influence of drugs as "drug crimes," assuming that 90 percent of such crimes also would have been undertaken in the absence of drugs. NDIC recognizes that this estimate may be conservative. If so, this approach conservatively underestimates drug crimes. (NDIC (2011), p. 8)

[21] The most recent NDIC estimate (published in 2011) uses survey data from 2002. Therefore, it is assumed that these percentages have not changed and thus are applied in every year of the calculation.

Table III.3
Share of Crimes that are Drug Related

Crime Category	Percent of Crimes that are Drug-Related
Aggravated Assault	4.4%
All Other Offenses	7.0%
Arson	1.3%
Burglary	32.3%
Curfew/Loitering/Vagrancy	N/A
Disorderly Conduct	N/A
Driving Under the Influence	3.5%
Drug Crimes	100.0%
Drunkenness	8.3%
Embezzlement	8.8%
Family and Children	5.1%
Forcible Rape	5.5%
Forgery and Fraud	32.2%
Gambling Offenses	N/A
Human Trafficking	N/A
Larceny-theft	28.8%
Liquor Laws	0.0%
Motor Vehicle Theft	24.1%
Murder	3.9%
Other Assaults	4.4%
Prostitution	51.1%
Robbery	29.5%
Sex Offenses	0.9%
Stolen Property	12.2%
Vandalism	2.8%
Weapons	3.0%

Source: Appendix III.C 3, Panel A.

39. Not all drug-related crimes are due to opioids. To estimate the share of these drug-related crimes that are opioid-related, two sources that measure the prevalence of opioid use are utilized. First, the share of crimes reported as drug crimes that are attributed to opioids is estimated using annual data on the share of drugs seized and tested by forensic laboratories in drug crime investigations reported by the National Forensic Laboratory Information System (NFLIS).[22] The opioid share of reported drug crimes is calculated using the share of such tests undertaken by forensic laboratories in Ohio in which an opioid was detected. In 2017, this share was 36.6%. To estimate the share of other "drug-related" crimes (other types of reported

[22] https://www.nflis.deadiversion.usdoj.gov/reports.aspx.

crimes that are attributed as drug-related as described above) that are attributable to opioids, annual data on the share of individuals with Substance Use Disorders (SUD) in Ohio that have Opioid Use Disorder (OUD), as reported by the National Survey on Drug Use and Health (NSDUH) are utilized.[23] Using these two sources of information on the opioid contribution to drug-related activities, the percentage of drug-related crimes that are due to opioids is calculated.

40. This method is applied to all divisions in the Bellwether governments that provide services related to crime, which include policing, courts and adjudication, and corrections. **Table III.4** below reports the resulting opioid-related percentages for these different divisions.[24] The calculations underlying the data presented in this table are available in **Appendix III.C**.

[23] Because the NSDUH definition of OUD changed after 2014 (and state-level responses are not available for 2014), this value from this calculation is held constant from 2013 onward. The actual percentages implied by the reported 2015 through 2017 data from NSDUH do not differ much from this assumption. I further understand that other experts discuss additional limitations regarding NSDUH data.

[24] **Table III.4** does not report the opioid-related percentages for the Juvenile Court divisions for either Summit or Cuyahoga as these calculations incorporate estimates on the extent of opioid-related activity for county divisions services provided to children and families, which are discussed below. Therefore, the Juvenile Court percentages are presented in Section IV.D after reviewing this calculation.

Table III.4
Opioid-Related Percent of Criminal Activity

Bellwether	Division		Metric	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cuyahoga	Prosecutor	[1]	Drug-Related % of Charges	34.0%	33.7%	33.3%	32.9%	32.8%	32.4%	32.6%	32.0%	28.6%	25.1%	25.9%	30.0%
	Public Defender	[2]	Opioid % of Drug Charges	16.3%	16.3%	21.5%	25.5%	29.2%	29.9%	30.2%	31.4%	32.8%	34.8%	35.0%	36.6%
	Sheriff	[3]	***Opioid-Related % of Charges***	***5.5%***	***5.5%***	***7.2%***	***8.4%***	***9.6%***	***9.7%***	***9.8%***	***10.1%***	***9.4%***	***8.7%***	***9.1%***	***11.0%***
	Court of Common Pleas	[4]	Drug-Related % of Adult Charges	35.1%	34.7%	34.3%	33.9%	33.8%	33.7%	34.5%	34.7%	32.1%	27.9%	28.7%	33.3%
	Jail	[5]	Opioid % of Drug Adult Charges	16.1%	16.1%	21.3%	25.4%	29.2%	29.8%	30.0%	31.2%	32.5%	34.6%	34.9%	36.6%
		[6]	***Opioid-Related % of Adult Charges***	***5.7%***	***5.6%***	***7.3%***	***8.6%***	***9.9%***	***10.1%***	***10.3%***	***10.8%***	***10.4%***	***9.7%***	***10.0%***	***12.2%***
Summit	Prosecutor	[7]	Drug-Related % of Crimes	28.3%	25.6%	24.9%	29.2%	25.5%	29.0%	29.5%	27.8%	29.6%	32.8%	33.6%	32.3%
	Court of Common Pleas	[8]	Opioid % of Drug Crimes	19.1%	19.7%	26.4%	27.5%	31.0%	31.0%	32.0%	33.2%	33.7%	35.0%	35.2%	36.6%
	Sheriff	[9]	***Opioid-Related % of Crimes***	***5.4%***	***5.0%***	***6.6%***	***8.0%***	***7.9%***	***9.0%***	***9.5%***	***9.2%***	***10.0%***	***11.5%***	***11.8%***	***11.8%***
	Adult Probation														
	Sheriff Jail	[10]	Drug-Related % of Prisoners	32.1%	32.0%	30.6%	29.9%	29.2%	28.6%	27.9%	27.9%	27.6%	26.9%	26.9%	26.9%
	Alternative Corrections	[11]	Opioid % of Drug Prisoners	17.1%	17.0%	22.5%	26.2%	29.8%	30.3%	31.1%	32.2%	33.1%	34.8%	34.8%	34.8%
		[12]	***Opioid-Related % of Prisoners***	***5.5%***	***5.4%***	***6.9%***	***7.8%***	***8.7%***	***8.7%***	***8.7%***	***9.0%***	***9.1%***	***9.4%***	***9.4%***	***9.4%***

[1] Appendix III.C.1, Panel A[3]
[2] Appendix III.C.1, Panel A[6]
[3] [1]*[2]
[4] Appendix III.C.1, Panel B[3]
[5] Appendix III.C.1, Panel B[6]
[6] [4]*[5]
[7] Appendix III.C.2, Panel A[3]
[8] Appendix III.C.2, Panel A[6]
[9] [7]*[8]
[10] Appendix III.C.2, Panel B[3]
[11] Appendix III.C.2, Panel B[6]
[12] [10]*[11]

B. Share of Addiction and Mental Health Activity Attributable to Opioids

41. The opioid crisis has resulted in increased costs faced by the Bellwether governments related to the funding of treatment for abuse and related services. These services are provided through the Alcohol, Drug Addiction, and Mental Health Services (ADAMHS) Board of Cuyahoga County and the Alcohol, Drug and Mental Health (ADM) Board of Summit County. These are quasi-independent boards that contract with provider agencies to provide mental health, addiction treatment and recovery services to the county residents.[25] These boards are funded in part by their respective counties.[26] To estimate the harms (costs of treatment and addiction services that are provided through these boards) due to opioids, the percentage of the Cuyahoga and Summit County contributions to their respective ADAMHS/ADM boards that were used for opioid-related services was estimated.

42. There are two elements of this calculation: (i) determination of the portion of board expenditures that are associated with addiction services, and (ii) determination of the portion of individuals receiving addiction services for opioids (for Cuyahoga) or the share of addiction expenditures used for OUD (for Summit).[27] These figures are identified in the ADAMHS and ADM boards' annual reports. It is then assumed that the share of Cuyahoga/Summit County contributions to their respective ADAMHS/ADM boards that is used for opioid-related services are equal to the percentage of these organizations' budgets that is used for providing opioid-

[25] See http://adamhscc.org/ and https://www.admboard.org/admboard-history.aspx for a description of these services.
[26] See McGuire Report, Appendices IV.C and IV.D for details on the counties' annual contribution to their respective boards.
[27] This element was calculated using different metrics across the two counties due to difference in data reported by Cuyahoga and Summit counties.

related services. The results of this analysis are summarized in **Table III.5** below and the calculations underlying these results are reported in detail in **Appendix III.D**.

Table III.5
Opioid-Related Percent of Treatment and Addiction Services

Division / Metric	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cuyahoga ADAMHS Board:												
[1] Addiction-Related % of Spending	23 9%	23.9%	23 8%	20.1%	19.3%	18.7%	18.7%	26 0%	23.5%	26.5%	27.1%	29.4%
[2] Opioid-Related % of Indiv. Treated	13.7%	16.2%	18.7%	21.2%	22.3%	22.1%	21.9%	26.7%	30.5%	33 2%	45.1%	47.5%
[3] **Opioid-Related % of Services**	**3.3%**	**3.9%**	**4.4%**	**4.3%**	**4.3%**	**4.1%**	**4.1%**	**6.9%**	**7.2%**	**8.8%**	**12.2%**	**14.0%**
Summit ADM Board:												
[4] Addiction-Related % of Spending	24 9%	24.2%	22 0%	20.5%	17.0%	16.8%	22.4%	31 2%	33.5%	33.6%	32.3%	32.4%
[5] Opioid-Related % of Addiction Spending	6.8%	8.0%	10 2%	13.9%	34.5%	33.3%	36.5%	38.7%	37.8%	39.2%	47.5%	42.4%
[6] **Opioid-Related % of Spending**	**1.7%**	**1.9%**	**2.2%**	**2.8%**	**5.9%**	**5.6%**	**8.2%**	**12.1%**	**12.7%**	**13.2%**	**15.3%**	**13.7%**

[1] Appendix III.D.1, Panel A[4]
[2] Appendix III.D.1, Panel A[8]
[3] [1]*[2]
[4] Appendix III.D.2, Panel A[6]
[5] Appendix III.D.2, Panel A[9]
[6] [4]*[5]

C. Share of Children's and Family Services Due to Opioids

43. The opioid crisis has resulted in increased demand for the provision of services to children and families.[28] Such services are provided by the Department of Children's and Family Services in Cuyahoga and Summit counties. These services support children of adults that misuse opioids, by either providing in-home support or removing the children and placing them in foster care.[29]

[28] Summit County Children Services 2016 Annual Report, p. 2 ("As a result of the explosion of substance abuse involved cases, especially from the recent opioid epidemic, the increased number of children who entered custody has had a dramatic impact on the agency's operating budget.") Deposition of Cynthia Weiskittel, Director of Children and Family Services Cuyahoga County, November 13, 2018, p. 35 ("I can say that our caseloads are up and that is due in part to the opioid situation"). See also, Adrienne DiPiazza, "Opioid crisis leaves more children needing foster care in Cuyahoga County," *Fox 8 Cleveland,* May 1, 2018, available at https://fox8.com/2018/05/01/opioid-crisis-leaves-more-children-needing-foster-care-in-cuyahoga-county/.
[29] Summit County Children Services 2016 Annual Report; Cuyahoga County Department of Health and Human Services, 2016 Annual Report, p. 9.

44. The share of foster care services attributable to opioids in the two Bellwether counties is based on a December 2017 publication by the Public Children Services Association of Ohio titled "The Opioid Epidemic's Impact on Children Services in Ohio."[30] This study reports the percentage of children taken into custody in 2015 in Summit and Cuyahoga counties that had parents who were using opioids at the time of removal. This percentage is then backcasted for 2006 through 2014 and forecasted for 2016 through 2017 under the assumption that opioid-related child removals track the trend in the annual changes of OUD treatment expenses in the counties. This is measured using the percentage of individuals receiving ADAMHS addiction services for opioids (for Cuyahoga) and in the percentage of addiction expenditures that are opioid-related (for Summit). These results are presented in **Table III.6** below for the two Bellwether counties and the calculations underlying these results are reported in detail in **Appendix III.E**.

Table III.6
Opioid-Related Percent of Child Removals

Division / Metric	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cuyahoga Children and Family Services:												
[1] Opioid-Related % of Removals	4.5%	5.4%	6.2%	7.0%	7.4%	7.3%	7 2%	8.8%	10.1%	11.0%	14.9%	15.7%
Summit Children Services Board:												
[2] Opioid-Related % of Removals	4.4%	5.1%	6.5%	8.8%	22.0%	21.2%	23.3%	24.7%	24.1%	25.0%	30.3%	27.0%

[1] = Appendix III.E.1, Panel A[1]
[2] = Appendix III.E.2, Panel A[1]

[30] The Public Children Services Association of Ohio (PCSAO) is an "association of Ohio's county Public Children Services Agencies that advocates for and promotes child protection program excellence and sound public policy for safe children, stable families, and supportive communities." (http://www.pcsao.org/who-we-are). The PCSAO study titled "The Opioid Epidemic's Impact on Children Services in Ohio" was published in December 2017 based on survey responses from 78 Public Children Services Agencies.

D. Share of Juvenile Court Activity Attributable to Opioids

45. As discussed above, the juvenile courts handle both criminal cases involving juveniles as well as child removals, both of which are affected by the opioid crisis. As such, the percentage of harms attributable to opioids for this division in Summit and Cuyahoga counties is calculated as sum of the percent of harms from criminal activity attributable to opioids and the percent of child removals that are attributable to opioids. This is calculated using data from Cuyahoga and Summit on the number and nature of the juvenile charges and cases that appeared in the juvenile courts over the time period. To calculate opioid-related juvenile cases related to juvenile criminal activity, the analysis starts first with the category of criminal charges reported for all 'Delinquency and Unruly' cases. The percent of these charges that are opioid-related is calculated using the same method and data as described above for criminal activity. Namely the percent of juvenile criminal charges that is drug-related is estimated using the DOJ study and the percent of these drug-related charges that are opioid-related are estimated using the DEA and NSDUH data.[31] The percent of charges that are opioid-related is then applied to the total number of these cases to arrive at an estimate of opioid-related criminal cases.[32] To estimate the number of opioid-related removal cases in the juvenile court, the percentage of opioid-related child removals (calculated in **Table III.6**) is applied to the number of 'Abuse, Dependency, Neglect' cases in the relevant year. The sum of these two calculations, as a percentage of total juvenile cases, provides an estimate of the percent of opioid-related case

[31] Data on the type of criminal charge for Summit Juvenile Charges is only available for 2014 through 2016. The remaining years are estimated by trending these values (back to 2006 and forward to 2017) based on the trend exhibited by Summit's opioid-related percent of criminal activity estimated in Table III.4.

[32] Note that a single case in the juvenile system can be associated with multiple charges.

activity in these courts and, thus, an estimate of the percentage of harms or costs incurred by the juvenile court system that are attributable to the opioid epidemic from an increase in both crime and child removals. **Table III.7** below reports these results. Detailed calculations underlying these results are available in **Appendix III.F**.

Table III.7
Opioid-Related Percent of Juvenile Court Activity

Division / Metric	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cuyahoga Juvenile Court:												
[1] Opioid-Related % of Juvenile Cases	1.6%	1.7%	2.4%	2.3%	2.4%	2.5%	2.3%	2.8%	3 3%	3.2%	4.3%	4 3%
Summit Juvenile Court:												
[2] Opioid-Related % of Juvenile Cases	2.6%	2.7%	3.4%	4.0%	4.4%	4.9%	5.3%	4.9%	5 3%	5.6%	6.8%	6 5%

[1] Appendix III.F.1, Panel A[11]
[2] Appendix III.F.2, Panel A[11]

E. Opioid Related Share of Medical Examiner Activity

46. The opioid crisis has resulted in increased costs by the Medical Examiner offices in both Cuyahoga and Summit counties as a result of the need to respond to the increase in opioid fatalities that lead to required autopsies. The share of activities undertaken by the Medical Examiner that are opioid-related is estimated using data on the share of in-county autopsies that are found to be opioid-related. This is calculated based on death records maintained by county officials, which identify whether opioids (of any type) were identified within the deceased.[33] **Table III.8** reports these estimates. The calculations underlying these estimates are available in **Appendix III.G.**

[33] Summit County and Cuyahoga County Medical Examiners' offices also perform autopsies for deaths that occurred outside of their respective county. These are excluded from the calculation.

Table III.8
Opioid-Related Percent of Medical Examiner Autopsies

Division / Metric	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cuyahoga Medical Examiner:												
[1] Opioid-Related % of Autopsies	9.1%	8.5%	12.0%	14.8%	17.1%	21.3%	21.5%	24.8%	24.4%	23.4%	37.9%	38.4%
Summit Medical Examiner:												
[2] Opioid-Related % of Autopsies	10.9%	10.5%	9.5%	13.3%	15.5%	12.6%	17.6%	15.5%	23.3%	27.0%	37.0%	31.9%

[1] = Appendix III.G.1, Panel A[3]
[2] = Appendix III.G.2., Panel A[3]

V. Estimation of the Relationship Between Shipments and Opioid-Related Mortality

47. The above section estimates the share of various harms faced by the Bellwether governments that are related to opioids for select divisions. However, because these jurisdictions would have faced some opioid-related costs even in the absence of the increasing availability of prescription opioids due to the defendants' misconduct, it is necessary to estimate the share of opioid-related harms that are attributable to shipments of prescription opioids. Data on opioid-related mortality provide the most comprehensive information available for identifying the impact of shipments on harms and these data are used to develop an estimate of the share of opioid-related harms attributable to shipments of prescription opioids for all the divisions. Mortality data also provide a useful measure of opioid-related harms because of the direct connection between availability of legal and illegal opioids and opioid-related deaths. Unlike crime or foster care placements, which are harms that one would expect would exist at some level even without opioids, there is no reason to expect there would be opioid-related deaths in the absence of supplies of prescription opioids and illegal substitutes.

48. Due to changes over time in how prescription opioid shipments affect mortality, and due to limitations of available data, two different statistical regression frameworks are applied to estimate the impact of shipments of prescription opioids on mortality. As noted above, the "direct approach" is based on the relationship between changes over time in opioid mortality across different geographic areas and shipments of prescription opioids to those areas. The "indirect approach" uses the relationship between opioid mortality across areas and social and economic characteristics of those areas prior to defendants' misconduct to project changes in opioid-related mortality expected in the absence of excessive shipments of prescription opioids (i.e. the level of prescription opioid shipments in excess of those that would be expected given the observed changes in the social and economic characteristics). The choice and application of both approaches is informed by the changing nature of the opioid crisis.

49. This section first describes the changing nature of the opioid crisis and how that guides the choice of the statistical modelling approaches. Afterwards, the implementation of these statistical models is discussed.

A. The Shift in the Relationship Between Prescription Opioid Shipments and Opioid Mortality Over Time

50. As discussed in the Gruber Report, there are distinct phases of the current opioid epidemic, with 2010 marking an approximate transition point for the beginning of the decline in overall prescription opioid shipments. Before this transition, the crisis was characterized by large and on-going increases in the shipments of prescription opioids and rapid increases in mortality associated with prescription opioids. For example, between 1999 and 2010, 85

percent of the increase in opioid mortality was attributable to increases in prescription opioid mortality.

51. In addition to the immediate damage it caused, the increase in opioid shipments prior to 2010 created a large number of opioid addicts. As noted in the Gruber Report, the existence of widespread dependence on opioids, coupled with a decline in the available supply of prescription opioids after 2010, led to an increased demand for illicit opioids, first heroin and later fentanyl.

52. Between 2010 and 2016, prescription (i.e. licit) opioid shipments fell. There were many causes of this including but not limited to: OxyContin was reformulated in an attempt to make it more difficult to abuse;[34] medical organizations began warning against excessive prescribing of opioids; and federal and state governments began expanding enforcement against "pill mills" and other forms of diversion of prescription opioids for non-medical use.[35] The FDA pointed to these various factors in their review of whether Purdue's reformulated OxyContin reduced abuse of the drug.[36]

53. While identification of the precise role of any individual supply-reducing factor is beyond the scope of this report, the development of abuse-deterrent formulations as well as other supply-limiting interventions clearly failed to eliminate either the widespread pre-existing

[34] As the FDA has argued, reformulation did not eliminate the potential for OxyContin to be abused as it is still possible to be abused orally (PPLPC005000211723, at 383).
[35] See, for example: National Academies of Science, "Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use," National Academies Press (2017), at p. 29 and 36; Evans, William N., Ethan Lieber, Patrick Power. "How the Reformulation of Oxycontin Ignited the Heroin Epidemic." Review of Economics and Statistics 101 no. 1 (2019): 1-15 (Evans et al. (2019)), at p. 11.
[36] PPLPC005000211723, at 28

dependence on opioids, or the addiction risk and the potential for abuse of illicit opioids. Furthermore, as also concluded by Professor Gruber, the increase in the demand for illicit opioids, and the associated increases in mortality, would not have occurred in the absence of the enormous increase in prescription opioid shipments resulting from defendants' misconduct, which effectively created a stock of individuals susceptible to illicit opioid use and abuse.

54. The combined consequence of these factors was a rapid growth in misuse of illicit opioids and increase in mortality due to heroin and fentanyl which began around 2010. The increase in deaths due to illicit opioid use far exceeded the decline in mortality associated with prescription opioids and thus, as a result, total mortality rose even as legal opioid shipments fell.

55. In short, the nature of the opioid crisis changed around 2010. This resulted in a shift in the relationship between shipments of prescription opioids and mortality that has been widely recognized in the economic literature.[37] Here, the shift reflects the dramatic increase in heroin-related mortality post-2010, which is confirmed by statistical analysis of changes in trends in heroin-related overdose mortality from 1999-2014. (The analysis is limited to this period given that the emergence of fentanyl resulted in further acceleration in deaths due to illicit opioid use around 2014).

56. To capture this shift in the relationship between shipments and mortality, a statistical analysis identified the month that best identifies the date at which the time series of heroin

[37] For example, *see*: Evans, et al (2019); Alpert, Abby, David Powell, and Rosalie Liccardo Pacula. "Supply-Side Drug Policy In The Presence Of Substitutes: Evidence From The Introduction Of Abuse-Deterrent Opioids." *American Economic Journal: Economic Policy* 10 (2018): 1-35.

[redacted]

[38] See Chow, Gregory C. "Tests of equality between sets of coefficients in two linear regressions." *Econometrica: Journal of the Econometric Society* 28 (1960): 591-605; Quandt, Richard E. "Tests of the hypothesis that a linear regression system obeys two separate regimes." *Journal of the American statistical Association* 55 (1960): 324-330; Fisher, Franklin M. "Tests of equality between sets of coefficients in two linear regressions: An expository note." *Econometrica: Journal of the Econometric Society* 28 (1970): 361-366; An F-statistic is used in econometrics to test whether the values across two groups differ from each other. The largest F-statistic identifies the month associated with the largest difference in the trends (growth rates) of heroin mortality between the two periods.

[39] Evans et al. (2019) present a similar analysis and reach a similar conclusion.

Source: NCHS Mortality Data

58. Consistent with the events described above, mortality associated with prescription opioids (not involving illicit opioids) also started to decline around the same time as the acceleration of illicit opioid deaths. A similar analysis establishes that the long-term trend of increasing prescription opioid mortality was reversed around the same time and that the best estimate of this shift was December 2010. **Figure III.3** reports the prescription opioid mortality rates and the regression estimate of the trends before and after the best estimate of the date of the shift in the rate.

Source: NCHS Mortality Data

59. The shift in the nature of the opioid crisis does not mean that historical levels of shipments are irrelevant to understanding the emergence of heroin opioid mortality. To the contrary, available data demonstrate that the increase in heroin-related mortality was greatest in counties with high historical levels of shipments and lower in areas with relatively lower levels of historical shipments. This pattern is consistent with the view that (i) historical shipments (and the consequent opioid dependence) played an important role in contributing to the demand for illicit opioids after 2010, and (ii) factors such as reduced shipments of prescription opioids and development of abuse deterrent formulations resulted in an increased demand for illicit opioids in all areas.

60. These effects are clearly demonstrated in the results of performing an additional test on annual heroin mortality data from two groups of counties: those with shipments of prescription opioids from 1997-2010 within the top 25% of counties ("high shipment counties") and those with shipments in the bottom 25% of counties ("low shipment counties").[40] **Figure III.4** summarizes this test, which establishes that while both areas have clear shifts in the trend in heroin mortality after 2010, the acceleration in heroin mortality is significantly larger in the high shipment counties. The difference in the change in slope and level is statistically significant.

Source: NCHS Mortality Data and ARCOS

[40] County-specific mortality data are only available on an annual basis. National data are available on a monthly basis.

61. This finding is consistent with the economic literature that has studied the transition from prescription to illicit opioids in the post-2010 time period. For example, Evans et al. (2019) evaluated a similar set of statistical tests using state-level mortality data and found evidence of substitution from prescription opioids to heroin. They conclude that "there appears to have been one-for-one substitution of heroin deaths for opioid deaths."[41] Similarly, Alpert et al. 2018 analyzed prescription shipments and mortality data in a panel data context and concluded that areas with high levels of abuse of OxyContin are associated with large increases in heroin mortality following 2010.[42] The same authors have now extended the work to study the growth in infections of hepatitis C since 2010 and conclude that areas with higher levels of OxyContin abuse have seen much larger growth in the virus, which is frequently contracted through intravenous drug use.[43]

62. Moreover, a number of epidemiological studies have established that much of the increase in the use of illicit opioids after 2010 was the result of addictions resulting from prior use of prescription opioids. Several of the studies are reviewed in the Gruber Report, so they are only briefly noted here.[44] Key studies establish that:

- A survey of heroin patients in drug treatment centers that reported initiating use in the 2000s established that 75 percent initiated opioid use with prescription opioids.

[41] Evans et al. (2019), at p. 2.
[42] Alpert, Abby, David Powell and Rosalie Liccardo Pacula. "Supply-Side Drug Policy in the Presence of Substitutes: Evidence from the Introduction of Abuse-Deterrent Opioids." *American Economic Journal: Economic Policy* 10 (2018): 1-35, p. 4.
[43] Powell, David, Abby Alpert, and Rosalie L. Pacula. "A Transitioning Epidemic: How the Opioid Crisis is Driving the Rise in Hepatitis C." *Health Affairs* 38 no. 2 (2019): 287-294.
[44] I understand that the Expert Report of Dr. Katherine Keyes also reviews related studies.

Among respondents that began using opioids in the 1980s, the comparable figure was 30 percent.[45]

- Analysis of NSDUH survey data established that among respondents that reported using both heroin and prescription opioids (for non-medical use), the share that reported initially using prescription opioids was 83 percent in 2008-10.[46]

63. These studies and the analyses presented above in **Figures III.2** through **III.4** demonstrate that the increase in deaths due to illicit opioid use is closely related to the growth in demand for illicit drugs after 2010. Since the increased demand for illicit opioids would not have occurred absent defendants' misconduct resulting in increased shipments of prescription opioids and CSA registrants' failure to identify excessive shipments, the resulting harm relating to illicit opioids is appropriately attributable to defendants' actions. Simply stated, the available data indicate that in the absence of shipments of prescription opioids, the post-2010 increase in mortality due to heroin and fentanyl would not have occurred. This is also confirmed by the analysis below.

B. Statistical Models of the Impact of Prescription Opioid Shipments on Mortality

64. Statistical analysis of the impact of shipments of prescription opioids on mortality must recognize both the dramatic change in nature of the opioid crisis after 2010 discussed above, as well as the limitations of available data. This section motivates and outlines statistical

[45] Cicero, Theodore J., Matthew S. Ellis, Hilary L. Surratt, and Steven P. Kurtz. "The changing face of heroin use in the United States: A retrospective analysis of the past 50 years." *JAMA Psychiatry* 71 (2014): 821-826, p. 823.
[46] Jones, Christopher M. "Heroin use and heroin use risk behaviors among nonmedical users of prescription opioid pain relievers—United States, 2002–2004 and 2008–2010." *Drug and Alcohol Dependence* 132 (2013): 95-100, p. 97.

frameworks for estimating the impact of shipments of prescription opioids on opioid-related mortality that are informed by the changing nature of the crisis and other factors.

1. Framework 1: Direct Estimation of the Impact of Shipments of Prescription Opioids on Mortality

65. The "direct estimation" framework uses regression analysis to estimate the relationship between the increase in opioid-related mortality in a geographic area and per capita shipments of prescription opioids to that geographic area. The analysis yields estimates of the magnitude and statistical significance of that relationship. Regression analysis is a reliable and commonly used method to analyze the relationship between economic variables. It is widely used in the fields of economics and other social sciences and in expert analysis for the purposes of litigation.[47] Examples of regression analyses similar to the "direct estimation" approach are discussed further below.

a. Regression Specification

66. The regression framework used to estimate the relationship between opioid shipments to an area and changes in opioid-related mortality can be expressed as the following:

$$\begin{pmatrix} Change\ in\ opioid\ - \\ related\ mortality \end{pmatrix}_i = \beta_1 \begin{pmatrix} Opioid\ shipments \\ per\ capita \end{pmatrix}_i + X_i\beta + \varepsilon_i$$

The analysis evaluates the relationship between change in mortality between two periods of time (e.g. between 1995 and 2010) in a county (*i*) to per capita shipments to that county, as well as to various economic and demographic characteristics of the county (X_i). The

[47] See, for example: Daniel L. Rubinfeld, "Reference Manual on Multiple Regression," *Reference Manual on Scientific Evidence* 3rd. Ed. Federal Judicial Center, National Academies Press (2011): 303-358.

relationship between the various explanatory variables and changes in mortality (β) are estimated in the regression model and ε_i reflects the change in mortality that is not explained by the regression. The key coefficient is β_1, which describes the magnitude of the relationship between prescription opioid shipments and opioid mortality, and for which we can also determine statistical significance. The regression model can then be used to project the change in mortality that would have been observed in the typical area if, for example, there had been fewer or no shipments of prescription opioids. These estimates, in turn, can be combined with estimates of the share of shipments that is attributable to defendants' misconduct described in the Rosenthal Report to yield an estimate of the share of opioid-related harms that can be attributed to prescription opioid shipments resulting from defendants' misconduct.

67. The regression analysis relates the changes in mortality in a county to the average level of per capita shipments to that county through 2010. As discussed above, mortality due to illicit opioids increased significantly after 2010. There continued to be deaths from "licit" opioids (prescription opioids other than fentanyl but including methadone) after 2010, although the rate of such deaths started to fall. As discussed further below, the estimated relationship between shipments and mortality through 2010 can be used to estimate the share of mortality from licit opioids that can be attributed to shipments of prescription opioids after 2010.

b. Limitations of Direct Model

68. The direct regression specification has two limitations that are discussed below. These limitations imply that (1) it is inappropriate to use a direct regression method to measure the effect of prescription opioids on opioid mortality after 2010; and (2) a direct regression method

likely understates the relationship between prescription opioid shipments on opioid mortality even for the period prior to 2010.

i. The Direct Regression Model is Not Suitable to Estimate the Relationship between Prescription Opioid Shipments and Opioid Mortality After 2010

69. As shown above, after 2010 declines in shipments of prescription opioids generated increased demand for illicit opioids and rapid increases in deaths due to illicit opioids. These events fundamentally altered the relationship between shipments of prescription opioids to an area and opioid-related mortality.

70. Specifically, the increase in deaths due to illicit opioid use after 2010 depends not just on the increase in demand for illicit opioids due to the decline in supply of prescription opioids, but also on the supply of illicit opioids in an area. For example, if two areas have the same increase in the demand for illicit opioids (due perhaps to having had the same level of historical shipments), deaths due to illicit opioid use would be likely to increase more in the area with greater supply of illicit opioids. Thus, the relationship between shipments and opioid-related mortality in the post-2010 period is likely to be weaker than the relationship in the earlier period.

71. The "supply side" of the illicit drug marketplace depends on factors such as the presence and sophistication of networks of drug dealers, their ability to increase supply of illegal opioids in response to an increase in demand, and the type of heroin which was being supplied to an area. Supply conditions in the illicit marketplace cannot be directly observed, due in part to the illegal nature of this activity. Nor can consumption of illicit opioids be observed – for the same

reason. Thus, some of the factors that contributed to the increase in mortality from illicit opioids after 2010 cannot be incorporated into a statistical analysis like that which is indicated for the analysis through 2010. However, the presence and sophistication of drug networks is partially a result of opioid shipments prior to 2010, as they created 'thicker markets' for illegal products.[48] This informs Framework 2, the methodology that is employed for the post-2010 period, which is described in detail further below.

ii. Impact of Mismeasurement on the Estimate of the Relationship Between Shipments and Mortality

72. Even limiting the direct analysis to the period up to and including 2010 would still understate the true impact of shipments on opioid mortality and thus is appropriately considered a "lower bound" estimate of this relationship. As explained further below, the estimation of the direct analysis establishes that the growth in opioid-related mortality through 2010 in an area is strongly related to shipments of prescription opioids to the area, and this relationship is statistically significant. However, as a general matter, the direct approach will understate the magnitude of the true relationship between prescription opioids and mortality.

73. To understand why, it is important to recognize that the ideal analysis would relate mortality to consumption of prescription opioids. While shipments to an area may be highly correlated with consumption, the two are not the same. In particular, some shipments to an area are transported and sold to people living in other areas. For example, Florida had one of the highest per capita shipments of prescription opioids in the late 2000s. However, it is widely

[48] See discussion of thicker markets in the Gruber Report and in Vulkan, Nir, Alvin E. Roth, and Zvika Neeman, eds. *The Handbook of Market Design*. Oxford: Oxford University Press, 2013, p. 3.

recognized that many prescriptions written by Florida physicians were diverted to other areas, including Ohio, Kentucky, West Virginia and other nearby states. This flow of prescription opioids was known as the "Oxy Express" and is discussed at length in *Dreamland* and elsewhere, including in the Evans et al. (2019) study referenced above.[49] Some of the defendants in this litigation have also acknowledged the existence of the "Oxy Express", including specifically to Ohio.[50] As a result, consumption per capita is likely to have been higher than shipments per capita in Ohio, but lower than shipments per capita in Florida.

74. However, data on consumption in an area are not available, so data on shipments to the area are used as a proxy for consumption. Standard econometrics texts recognize that measurement error of this type will result in regression estimates that underestimate the magnitude of the true underlying economic relationships.[51] Here, the estimated relationship between shipments and mortality will understate the relationship between consumption and mortality.

75. Moreover, available data on shipments are defined on the basis of morphine equivalents (MMEs) per capita. While this provides a comprehensive measure of shipments of prescription opioids measured on an "apples to apples" basis, it does not permit the evaluation

[49] Quinones, Sam. *Dreamland: the true tale of America's opiate epidemic*. New York, NY: Bloomsbury Press, 2016, pp. 241-246. This phenomenon is also discussed in Evans et al. (2019) at p. 11. See also, Alan Johnson, "Florida urged to keep tracking painkillers; Program essential to curb 'pill mills,' Ohio's Sen. Brown tells Gov. Scott," *The Columbus Dispatch*, March 5, 2011; Amy Hollyfield, "Gov. Rick Scott signs legislation to crack down on pill mills," *St. Petersburg Times*, June 3, 2011; Lizette Alvarez, "Florida Shutting 'Pill Mill' Clinics," *The New York Times,* September 1, 2011. See also discussion in the Gruber Report.

[50] See, e.g., January 15, 2019 Deposition Transcript of Karen Harper, Director of Controlled Substance Compliance, Mallinckrodt, at pp. 91-92.

[51] See, for example, Wooldridge, Jeffrey M. *Econometric analysis of cross section and panel data*. Cambridge, Massachusetts: MIT press, 2010, pp. 80-81 for a discussion of errors in variables.

of prescription-level characteristics that also may affect misuse and mortality. For example, available data do not permit analysis of the impact on mortality of factors such the average number of days for which prescriptions are written, whether the prescribed drug was long acting or extended release formula, or the average dosage prescribed per day. Each of these is likely to affect the relationship between shipments and addiction, crime, mortality, and other outcomes. For the same reason just discussed above, this type of mismeasurement problem would also be expected to lead to an underestimate of the true relationship between consumption and mortality.

2. Framework 2: Indirect Approach to Estimating the Impact of Shipments on Opioid Mortality

76. An indirect regression method is an alternative way to estimate the impact of defendants' actions on mortality.[52] This method is based on a regression analysis of the relationship between opioid mortality in a given geographic area and the economic and demographic characteristics of an area in a period that (arguably) precedes increases in prescription opioid shipments due to the defendants' misconduct. This regression is then used to predict the opioid mortality rates that would have been expected given changes in economic and demographic factors in the absence of the increase in prescription opioid shipments due to the defendants' misconduct. The gap between actual mortality and this "but for" mortality yields an alternative estimate of the impact on mortality from the increase in shipments of prescription opioids above the baseline level of shipments predicted by the economic and demographic characteristics in that area.

[52] See discussion below on the general applicability and reliability of indirect regression methods in economics.

77. The regression equation used in the indirect approach can be expressed:

$$Opioid\ Mortality\ Rate_i^{Pre} = X_i^{Pre}\,\beta + \varepsilon_i$$

The analysis evaluates the relationship between mortality in the "pre-period" (before defendants' alleged misconduct and resulting impact on shipments) in county *i* and various economic and demographic characteristics of the county (X_i). The relationships between the various explanatory variables and pre-period mortality (β) are estimated in the regression model where ε_i reflects the portion of the county-level mortality in the "pre-period" that is not explained by the regression. As discussed further below, the regression analysis accounts for a wide variety of factors that potentially affect opioid mortality including the demographic characteristics of the population and various measures of economic opportunity.

78. Based on these estimates of the relationship between the economic and demographic characteristics of counties and opioid mortality in the "pre-period," the model can then generate estimates for "but for" opioid mortality in the "post-period" by predicting mortality using changes in the X_i variables over time. As discussed further immediately below, two versions of the indirect model are used in the analysis:

- First, an indirect model is used to estimate the level of deaths due to illicit opioid use that would have been observed in the absence of the increase in demand for illicit opioids after 2010. This version of the indirect model is used in conjunction with the direct model for 2010 and earlier years to estimate the harms due to defendants' misconduct after 2010.

- Second, recognizing that the direct regression reflects a lower bound estimate of the impact of shipments on opioid-related mortality, an indirect model is used to estimate the level of mortality due to opioids (licit and illicit) that would have occurred between 2006-2016.[53]

79. In each case, the difference between the actual and "but for" estimates of opioid-related mortality can be attributed to shipments of opioids. In applying the indirect model to the post-2010 period, the analysis accounts for the impact of changes in demographic and economic conditions in 2011-2016 on mortality. The increase in deaths due to illicit opioid use observed after accounting for those changes reflects the impact of events that would not have been observed in the absence of prior shipments. In applying the indirect model to the full 2006-2016 period, the analysis accounts for changes in demographic and economic conditions that might have affected opioid-related mortality over the entire time period.

80. Application of indirect models is an analysis that is widely used to evaluate economic impact.[54] This analysis is useful when the independent variable one wishes to measure is unavailable or is measured only with error. I used this methodology in my study examining price indices for heart attack treatment, which was awarded the Griliches Prize in Empirical Economics,[55] and in another paper examining the costs and benefits of technological change for

[53] The indirect regression attributes the entirety of unexplained opioid-related mortality to shipments. To the extent that other factors not modelled in the "baseline" regression contributed to increases in opioid mortality, the indirect approach has the potential to overstate the impact of defendants' actions.
[54] Indirect models are also referred to as "residual" models.
[55] Cutler David M., Mark McClellan, Joseph P. Newhouse and Dahlia Remler. "Are Medical Prices Declining? Evidence from Heart Attack Treatments," *Quarterly Journal of Economics* 113(4) (November 1998): 991-1024.

low birthweight infants.[56] This method also formed the basis for a widely cited study by Joseph Newhouse arguing that technical change was the primary driver of medical care costs over time.[57] Outside of health care, the indirect method is the standard framework used to assess macroeconomic productivity[58] and the effect of information disclosures on stock prices, among other areas.[59] The indirect method is also closely related to the literature on the economic analysis of wage differences across groups and discrimination. Translating the nomenclature of Fortin et al. (2011)[60] from labor economics to the empirical problem addressed here, the predicted mortality rate is the explained component of the Oaxaca-Blinder decomposition, and the residual is the unexplained component.[61]

C. Implementation of the Statistical Models of the Impact of Prescription Opioid Shipments on Mortality

81. This section discusses the estimation of direct and indirect regression specifications that ultimately forms the bases for the two approaches that are undertaken to estimate the percent of harm due to prescription opioid shipments that are attributable to defendants' misconduct. As previously noted, one approach incorporates estimates from a direct regression estimating

[56] Cutler David M. and Ellen Meara. "The Technology of Birth: Is It Worth It?" in Alan Garber, ed., *Frontiers in Health Policy Research, Volume 3*, Cambridge, MA: MIT Press, 2000, 33-67.
[57] Newhouse, Joseph P. "Medical Care Costs: How Much Welfare Loss?" *Journal of Economic Perspectives* 6 (1992): 3-21.
[58] Solow, Robert M. "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics* 39 (August 1957): 312-320.
[59] McKinlay, A. Craig. "Event Studies in Economics and Finance." *Journal of Economic Literature* Vol. XXXV (March 1997): 13-39.
[60] Firpo S, Lemieux T, Fortin N. "Decomposition Methods in Economics." In D. Card and O. Ashenfelter, eds., *Handbook of Labor Economics*, 4th Edition, North Holland: Elsevier(2011): 1-102.
[61] In many discrimination contexts, the analyst wishes to further decompose the residual into coefficients on the included variables and the coefficient on the constant, as the latter possibly suggests uniform discrimination, but that is not the case here. Misconduct on the part of the defendants could lead to either uniform increases in mortality or increases in mortality in areas with particular demographic or economic features. The simpler form of the Oaxaca-Blinder decomposition is thus employed in this analysis.

the relationship between prescription opioid shipments up until 2010 coupled with the results of an indirect regression used to predict "but for" illicit mortality after 2010. A second approach employs an indirect regression method estimating the harm from prescription opioids to predict "but for" opioid mortality over the entire post-1995 period. These approaches are discussed below, and their evaluations are discussed in more detail later in Section VII.

1. Implementation of Direct Regression Model to 2010

82. As noted, the direct analysis is based on regression estimates of the relationship between the change in the mortality rate over time in a given geographic area and per capita shipments of prescription opioids to the area.[62] Because this specification cannot fully account for the transition from licit to illicit opioids after 2010, the change in mortality is evaluated based on the difference in average opioid-related mortality rates in an area between 1993-95 and 2009-2010. Multiyear averages are used to dampen any effect of random fluctuations in opioid mortality rates in a given area, recognizing that random fluctuations will have a larger effect on data from any given year compared to data from multiple years. As noted in the **Data Appendix**, mortality rates are adjusted for changes in coding between ICD-9 and ICD-10 in 1999 and also for underreporting for type of drug in drug-overdose deaths, as in the work of Christopher Ruhm.[63]

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[62] The first year for which opioid shipment data are available is 1997. The attached **Data Appendix** provides details on the calculation of mortality rates, as well as details about the construction of the data on per capita shipments.

[63] For discussion of Ruhm's adjustment for underreporting of type of drug in drug overdose deaths see: Ruhm, Christopher J. "Geographic Variation in Opioid and Heroin Involved Drug Poisoning Mortality Rates." *American Journal of Preventive Medicine* 53 (2017): 745-753; Ruhm, Christopher J. "Corrected US opioid-involved drug poisoning deaths and mortality rates, 1999–2015." *Addiction* 113 (2018): 1339-1344.; Ruhm, Christopher J. "Deaths of Despair or Drug Problems?" NBER Working Paper 24188 (January 2018) (Ruhm (2018)). See attached **Data Appendix** for a detailed discussion on these adjustments.

83. Per capita shipments are calculated using ARCOS data on shipments of prescription opioids between 1997 (the first year for which data are available) and 2010, the last year prior to the shift in the opioid marketplace. For the purposes of the analysis, per capita shipments are expressed in terms of average MMEs per person per day in a county.[64] As noted in the **Data Appendix**, per capita opioid-shipments used in these models differ very slightly from the IQVIA data used by Prof. Rosenthal. With the IQVIA data, Schedule II and Schedule III opioids can be differentiated. With the ARCOS data, this delineation is not possible. However, the issue affects less than 2.6 percent of the drug shipment in ARCOS, and the correlation between shipments of Schedule II opioids from IQVIA and shipments of all opioids from ARCOS is 0.9973, implying this issue is of only minimal importance.

84. This framework reflects an application of the "long difference" methodology that is widely used in economics. The general approach has previously been applied to evaluate the impact of expanded trade with China on employment by industry and geography, the effect of crime on property values over the long run, and the contribution of economic factors to drug overdoses.[65] In my own work, I have used "long difference" models in health economics,

[64] See the attached **Data Appendix**.

[65] For example, see: Autor, David H., David Dorn, and Gordon H. Hanson. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States." *American Economic Review* 103 (2013): 2121–2168; Autor, David H., David Dorn, and Gordon H. Hanson. "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade." *Annual Review of Economics* 8 (October 2016): 205-220; Ruhm (2018); Devin G. Pope and Jaren C. Pope. "Crime and Property Value: Evidence from the 1990s Crime Drop." *Regional Science and Urban Economics* 42 (2012): 177-188.

including in examining changes in suicide over time (Cutler et al. (2001)) and in analyzing the value of medical improvements over time (Cutler et al. (2006)), among other areas.[66]

85. The long difference methodology is ideal to use here because the model accounts for the fact that there may be a non-instantaneous relationship between prescription opioid shipments and opioid mortality, as for example would be a result of long-term effects of addiction. Additionally, applying the long difference approach is useful when there is measurement error in the dependent variable. The observed rates of harms (e.g. annual opioid mortality rates) reflect the true harm plus an error – for example, inaccurate reporting of cause of death or random factors that lead opioid mortality to be particularly high or low in a given year. Therefore, the change in mortality rates over any period will reflect true 'signal' plus 'noise'. Over longer periods of time, the signal component increases in magnitude, while the noise component likely stays the same. Thus, estimates over longer periods of time will be more precise than estimates over shorter periods of time.

86. The direct regression analysis attempts to ensure that estimates of the relationship between shipments and mortality properly control for other factors that might affect opioid mortality. One variable included in the model is the area's opioid mortality rate in 1993-95. Inclusion of this variable is designed to capture any mean reversion in mortality rates. Such an effect occurs when, for example, areas with lower initial morality may have larger mortality

[66] Cutler, David M., Edward L. Glaeser and Karen E. Norberg. "Explaining the Rise in Youth Suicide," in Jonathan Gruber, ed., *Risky Behavior Among Youths: An Economic Analysis*, Chicago: University of Chicago Press, 2001: 219-269 (Cutler et al (2001)); Cutler, David M., Allison B. Rosen and Sandeep Vijan. "Value of Medical Innovation in the United States: 1960-2000." *New England Journal of Medicine* 355:(2006): 920-927.

increases simply because they are catching up to their peer areas (or vice-versa). Such "mean reversion" would be expected if, for example, opioid mortality was unusually high or low for reporting reasons in the initial period.

87. The specifications of the other independent variables in the direct and indirect models are similar. Since the dependent variable in the direct model is the *change* in mortality, it is appropriate for the independent variables in the direct model to include the *change* in the X_i variables between the beginning and ending time periods. In addition, the level of the X_i^{Pre} variables may be related to the change in mortality, if for example the coefficients on the X_i variables are changing over time. Thus, the X_i^{Pre} variables are also included in the regression, along with the change in the X_i variables.

88. The X_i variables include a variety of economic and demographic characteristics that might influence mortality, many of which are typically used in studies as controls for mortality change.[67] As noted above, the indirect models include the levels of economic and demographic variables, while the long difference model includes those levels as well as their changes over the time period. Demographic variables in the model include the percent of the population that is male, the percent in different age groups (<15, 15-29, 30-44, 45-64, 65+), the percent of the population that is white, the percent that is black, the percent that is Hispanic, the share of the population in four different education groups (less than a high school degree, a high school

[67] See, e.g., Case, Anne and Sir Angus Deaton. "Mortality and Morbidity in the 21st Century." *Brookings Paper on Economic Activity*. (Spring 2017): 397-443 (Case and Deaton (2017)); Case, Anne and Angus Deaton, "Rising Morbidity and Mortality In Midlife among White Non-Hispanic Americans in the 21st Century." *Proceedings of the National Academy of Sciences* 112(2015): 15078-83 (Case and Deaton (2015)).

degree only, some college, and a college degree or higher), and the percent of the county identified as urban.[68] Economic variables are also included to capture the potential relationship between the economic conditions of a county and its mortality rate. Following Case and Deaton (2015, 2017) and Ruhm (2018), the model includes the unemployment rate and employment-to-population ratio; the distribution of employment by major industry sector; median household income ($000); the poverty rate; and the county's population.[69] In the direct model, appropriate specification includes the lagged mortality rate as an independent variable, as I explained above, in order to allow for any possible mean reversion in mortality across areas.

89. The equations for the direct and indirect mortality regressions can be estimated using either the mortality rate or the logarithm of the mortality rate as the dependent variable. Studies of opioid mortality in the literature use either the level or logarithm of mortality. For example, Ruhm (2018) and Evans, et al (2019) estimate models for mortality in levels, while Gordon and Sommers (2016) use a logarithmic specification.[70] Indeed, I have used each in my own work on mortality changes.[71] In the case of the indirect model, the logarithm of mortality

[68] The variables used in the regression analysis, including means and coefficient estimates, are reported in the attached **Appendix III.H**.

[69] Case and Deaton (2015); Case and Deaton (2017); Ruhm (2018).

[70] Ruhm (2018); Evans et al (2019); Gordon, Sarah H. and Benjamin D. Sommers. "Recessions, Poverty, and Mortality in the United States: 1993-2012." *American Journal of Health Economics* 2(2016):489-510.

[71] Studies of mine that explain the level of mortality include: Cutler, David M. "The Lifetime Costs and Benefits of Medical Technology," *Journal of Health Economics*, 26(2007): 1081-1100; Cutler et al. (2001); Cutler DM, McClellan M, Newhouse JP. "How Does Managed Care Do It?" *Rand Journal of Economics* 31(Autumn 2000): 526-548. Studies of mine that explain the logarithm of mortality include: Cutler, David M. and Grant Miller. "The Role of Public Health Improvements in Health Advances: The 20th Century United States," *Demography* 42(February 2005): 1-22; Brainerd, Elizabeth and David M. Cutler. "Autopsy on an Empire: Understanding Mortality in Russia and the Former Soviet Union." *Journal of Economic Perspectives*, 19(Winter 2005): 107-130; Cutler, David M.,

is used as the independent variable because it is most natural to consider socioeconomic factors as increasing or reducing mortality by a certain percentage, which is approximated by the logarithmic specification. In the case of the direct model, because the baseline opioid-related mortality rate is sufficiently low, the logarithm of baseline mortality is subject to substantial variability across areas. For this reason, using the level (instead of the logarithm) of "pre- period" opioid mortality in the direct regression is preferred and therefore, the dependent variable itself is specified in levels.

90. The relationship between opioid shipments and mortality may vary across areas, for example in more or less populated areas. Measurement error in true death rates also varies across areas based on population size. Both Cuyahoga County and Summit County are highly populated relative to the average size of counties in the country. For this reason, only large counties are included in the analysis. As discussed in the attached **Data Appendix**, the analysis uses data on counties identified in all available years of the Multiple Causes of Death (MCOD) data, which reflects counties with population in excess of roughly 100,000. The large counties included in the analysis account for 69.3 percent of the U.S. population and [redacted] percent of opioid-related mortality as of 2016. The correlation between the national opioid mortality rate and the aggregate rate for the large county sample between 1993 and 2016 is 0.996.[72] Because the analysis relies on large counties, the data are not weighted in the model estimation.

Felicia Knaul, Rafael Lozano, Oscar Mendez and Beatriz Zurita. "Financial Crisis, Health Outcomes, and Aging: Mexico in the 1980s and 1990s." *Journal of Public Economics*, 84(May 2002): 279-303.

[72] This correlation is calculated for data that adjusts for changes in ICD codes in 1999 and includes the "Ruhm" adjustment for death records that do not report the reason for drug-related deaths.

91. The estimated relationship between the growth in the opioid mortality rate and prescription opioid shipments to an area is shown in **Appendix III.H**. The first column shows the means of the dependent and independent variables. The average county had shipments equal to 1.45 MME per capita per day. The remaining columns show the coefficient estimates. Overall, the model fits well. The adjusted R^2 coefficient of 0.57 is quite high for cross-sectional regressions of changes in mortality rates.[73] The coefficients on the demographic and economic variables are generally as expected. Opioid-related mortality went up more in areas where people had fewer years of education and where economic conditions were worse.

92. The coefficient on opioid shipments is most important for this analysis. The coefficient is positive and significant statistically. The probability that a result of this magnitude would occur by chance is less than 1/100th of one percent. The results indicate that, all else equal, each unit increase in shipments between 1997 and 2010 (measured in MME per capita per day) raises the mortality rate by [redacted] deaths per 100,000, an increase of more than [redacted] percent over the average rate in the base period. A unit increase in shipments corresponds to [redacted] percent increase from [redacted] shipment level across all areas. In summary, these results show that even with very extensive controls for economic and social factors, there remains a strong, statistically significant, and large relationship between prescription opioid shipments and opioid-related mortality through 2010. The specific magnitude of this effect and its implication on the analysis is presented in the following section.

[73] The R^2 coefficient reflects the proportion of the variance in the dependent variable (here opioid-related mortality rates) that is explained by the variance in the independent variables (here prescription opioid shipments and demographic and economic variables). The adjusted-R^2 adjusts for the number of covariates included in the model, so that including more variables does not automatically indicate a better fit. This statistic can be used as a measure of the "goodness of fit" of the regression model.

2. Implementation of Indirect Model for Illicit Mortality Post-2010

93. As noted above, the indirect regression model estimates the relationship between the opioid mortality rate in an area and the economic and demographic characteristics of the area. The regression estimates are then used to project how opioid mortality would have changed in response to changes over time in the economic and demographic characteristics, but without misconduct on the part of the defendants.

94. The indirect regression model for the post-2010 period is used to evaluate how deaths due to illicit opioids would have changed after 2010 in response to changes in economic and demographic factors in the absence of the increased demand for illicit opioids. The regression model explains variation across counties in the average death rate due to use of illicit opioids in 2008-2010. The death rate due to use of illicit opioids is defined to include any death involving heroin and/or fentanyl.[74] The multiyear average is used to dampen any effect of random fluctuations in mortality due to use of illicit opioids. Like the direct regression, the indirect regression includes controls for county-specific demographic and economic characteristics. Demographic characteristics include: the distribution of area population by age, race, gender and educational attainment, as well as percent urban. Also included are economic indicators including the unemployment rate and employment-to-population ratio; median household income; the employment share by major industry sector; and the county's population. The independent variables are all measured based on the average from 2008-2010.

[74] As above, the data used in the indirect regression incorporate the adjustment proposed by Christopher Ruhm.

95. As in the direct analysis, the indirect regression model is estimated on data from large counties, as defined above and therefore, again, the data are not weighted in the model estimation. The regression model is estimated in "semi-log" form, in which mortality due to illicit opioids is expressed in logarithmic terms and other economic and demographic variables are not. This specification yields estimates of the (approximate) percentage effect on illicit mortality resulting from a unit change in economic and demographic factors.

96. **Appendix III.H** reports the variable means and coefficient estimates for this regression model. The overall model fits well, with an adjusted R^2 of 0.31. The regression results show many of the same features as with the direct model. As with the direct model, areas where the economy was worse by most measures have higher mortality.

97. The results of the regression model, together with data on explanatory variables for 2011-16 are then used to predict "but for" mortality rates for illicit opioids for 2011-16 that would have been observed in the absence of the shift into illicit opioids after 2010 that resulted from earlier shipments of prescription opioids. As shown in **Figure III.5**, deaths due to illicit opioid use increased dramatically after 2010 but projections of the average but for illicit mortality rate based on the 2008-10 regression indicate that illicit mortality would have fallen in the absence of the decline in shipments of prescription opioids and the increased demand for illicit opioids after that time. To understand this predicted decline, recall that, on average over the counties, the economy improved over this time period, so this component of the model predicts fewer opioid-related deaths.

Source: NCHS Mortality data and US Census data

3. Estimation of Indirect Model for Total Mortality for 1995-2016

98. An indirect model was also implemented to estimate the effect of prescription opioids on total opioid mortality over the entire 1995-2016 time period. This indirect model relates the county-specific average opioid mortality rate for all types of opioids from 1993-95 to economic and demographic factors in the county. The multiyear average is used to dampen any effect of random fluctuations in opioid mortality rates that may occur in a single year. Like the direct and indirect models noted above, the regression controls for county-specific demographic and

economic characteristics, including the distribution of area population by age, race, gender and education; the percent urban; the unemployment rate and employment to population ratio; median household income; the employment share by industry sector; and county population. In each case, the 1993 to 1995 average of these control variables is included in the regression. Again, as mentioned above, the data are limited to large counties and therefore the regression is not weighted and is estimated using a semi-log functional form.

99. **Appendix III.H** reports the variable means and coefficient estimates for this regression model. The overall model fits well, with an adjusted R^2 of 0.31. The regression results show many of the same features as with the direct model and the indirect model for the later time period. In particular, for most measures of economic activity, areas where the economy was worse have higher mortality rates.

100. The results of the regression model, together with data on explanatory variables for 1996-2016, are then used to predict mortality rates for the post-1995 period that would have been observed in the absence of the acceleration in prescription opioid shipments after 1995. As shown in **Figure III.6** opioid mortality increased dramatically after 1995 but projections of the average "but for" opioid related mortality on the 1993-95 indirect regression model indicate that opioid mortality generally would have been stable in the absence of defendants' actions.

Source: NCHS Mortality data and US Census data

VI. Estimation of the Share of Opioid-Related Mortality Attributable to Shipments Resulting from Defendants' Misconduct

101. This section summarizes the estimates of the impact on opioid-related mortality from prescription opioid shipments resulting from defendants' misconduct. These results are inputs into the estimates of damages reported by Professor McGuire and are reported on a year-specific basis for 2006-16. These calculations combine (i) estimates of the share of shipments of prescription opioids that are attributable to defendants' misconduct estimated by Prof. Rosenthal, with (ii) each of the two approaches to estimating the impact of shipments of

prescription opioids on opioid-related mortality, which are described below.[75] The analysis yields year-specific estimates of the share of opioid mortality that is attributable to defendants' misconduct. **Appendix III.I** presents an analysis of the share of opioid mortality due to all prescription opioid shipments. **Appendix III.J** presents a discussion of how the estimates in this section could be modified for the purpose of estimating the share of harms due to CSA registrants' failure to take appropriate actions in monitoring excessive prescription opioid shipments. Finally, **Appendix III.K** presents the analysis incorporating Professor Rosenthal's alternative estimate of the share of prescription opioids due to defendants' misconduct using the indirect shipments regression method.

A. Approach 1

102. Approach 1 estimates the impact of defendants' misconduct on opioid mortality in three parts:

1. The share of opioid-related mortality from 2006 to 2010 that is attributable to defendants' misconduct is calculated using the results of the direct regression model and incorporating the estimates of the share of prescription opioid shipments due to defendants' misconduct calculated by Prof. Rosenthal;

2. The share of *licit* opioid-related mortality from 2011 to 2016 that is attributable to defendants' misconduct is calculated using the results of the direct regression

[75] This analysis can be readily adapted to alternative estimates that are based on individual manufacturer conduct. In general, any revisions to the estimates from Prof. Rosenthal could be readily incorporated into this analysis.

model and incorporating the estimates of prescription opioid shipments due to defendants' misconduct calculated by Prof. Rosenthal; and

3. The share of deaths due to *illicit* opioids from 2011 to 2016 that is attributable to defendants' misconduct is calculated using an indirect regression model that estimates the increase in illicit opioid mortality that is unexplained by social and demographic factors relative to the pre-2011 baseline.

103. This analysis is described in more detail below. As noted, each of these estimates incorporates the share of prescription opioid shipments due to manufacturers' marketing misconduct estimated in the Rosenthal Report. This section first summarizes those estimates and then provides a detailed description of the three calculations that together yield the estimates of the share of harms attributable to defendants' misconduct under Approach 1.

1. Estimate of But-For Shipments

104. A required input in estimating the share of opioid-related mortality attributable to defendants' conduct is the estimate of prescription opioid shipments that would have existed but-for the defendants' misconduct as estimated in the Rosenthal Report. **Table III.9** below presents these calculations that incorporate the estimation of the impact of defendants' misconduct on shipments based on the direct shipments regression method that is presented by Professor Rosenthal. The results presented below are based on this approach while **Appendix III.K** presents a parallel set of results based on the Professor Rosenthal's estimation of the impact of defendants' misconduct on shipments using the indirect shipments regression method that is also presented in her report.

105. Specifically, but-for average shipments (**Table III.9** Column D) are first calculated by multiplying actual average shipments (**Table III.9** Column A) by one minus the estimated share of shipments due to defendants' misconduct using the direct shipments regression method for each year (**Table III.9** Column C). Using this series of but-for average shipments, the cumulative average of but-for shipments is calculated (**Table III.9** Column E). For each year, the cumulative weighted average of shipments attributable to defendants' misconduct is then calculated to yield an estimate of the share of cumulative shipments in each year that are attributable to defendants' misconduct (**Table III.9** Column F).[76] Use of the cumulative weighted average recognizes that shipments attributable to defendants' misconduct in one year can affect misuse and addiction in later years.[77] These estimates are then incorporated in the evaluation of the regression estimates for Approach 1 and Approach 2, described in more detail below.[78]

[76] The weighted average is calculated using year-specific shipments as weights, so years with more shipments are properly reflected in the calculation.

[77] Note that this approach assumes that the relationship between cumulative average shipments and mortality holds in the data in every year.

[78] Estimates of the share of opioid-related mortality due to all prescription opioid shipments (as opposed to shipments attributable to defendants' misconduct) can be estimated under Approach 1 and Approach 2. The results of this analysis is presented in **Appendix III.I**.

Table III.9
Cumulative But-For Shipments
1997-2016

Year	Average Shipments per Capita per Day	Cumulative Average Shipments	Percent of Shipments Attributable to Defendants' Misconduct	But-For Average Shipments per Capita per Day	But-For Cumulative Average Shipments	Weighted Average Cumulative Percent of Shipments Attributable to Defendants' Misconduct
	A	*B*	*C*	*D = A * (1-C)*	*E*	*F = (B-E)/B*
1997	0.46	0.46	18.2%	0.38	0.38	**18.2%**
1998	0.55	0.50	22.8%	0.42	0.40	**20.7%**
1999	0.66	0.56	27.6%	0.48	0.43	**23.4%**
2000	0.86	0.63	33.4%	0.57	0.46	**26.8%**
2001	1.02	0.71	38.8%	0.62	0.49	**30.3%**
2002	1.19	0.79	43.4%	0.67	0.52	**33.6%**
2003	1.42	0.88	47.0%	0.75	0.56	**36.7%**
2004	1.56	0.96	49.5%	0.79	0.59	**39.3%**
2005	1.62	1.04	50.8%	0.80	0.61	**41.3%**
2006	1.84	1.12	50.7%	0.91	0.64	**42.8%**
2007	2.09	1.21	52.3%	1.00	0.67	**44.3%**
2008	2.18	1.29	52.9%	1.03	0.70	**45.5%**
2009	2.32	1.37	53.5%	1.08	0.73	**46.6%**
2010	2.53	1.45	54.1%	1.16	0.76	**47.5%**
2011	2.58	1.53	54.8%	1.17	0.79	**48.3%**
2012	2.55	1.59	55.7%	1.13	0.81	**49.1%**
2013	2.42	1.64	57.3%	1.03	0.82	**49.8%**
2014	2.36	1.68	59.6%	0.95	0.83	**50.6%**
2015	2.27	1.71	61.0%	0.88	0.83	**51.3%**
2016	2.08	1.73	61.6%	0.80	0.83	**51.9%**

Note: Column C based on direct shipments regression analysis presented in Rosenthal Report.

2. All Opioid Mortality from 2006 to 2010

106. For years prior to 2011, the impact of defendants' actions on opioid mortality is calculated by comparing the actual change in mortality over this period with the (direct) regression-based estimate of the change in mortality evaluated using estimates of "but for" shipments that exclude those attributed to defendants' misconduct.

$$Actual\ Change = M_{Post\ Actual} - M_{Pre} = \alpha + \beta_1 S_{Actual} + X\beta + \epsilon$$

$$But\ For\ Change = M_{Post\ But-For} - M_{Pre} = \alpha + \beta_1 S_{But-For} + X\beta + \epsilon$$

$$Impact = M_{Post\ Actual} - M_{Post\ But-For} = \beta_1 (S_{Actual} - S_{But-For})$$

107. Here, M is the mortality rate, S is shipments, and β_1 reflects the regression estimate of the relationship between average annual per capita shipments over the 1997-2010 period in an area and the change in the rate of opioid-related mortality between 1993-95 and 2009-10. S_{Actual} reflects the actual level of average annual per capita shipments of prescription opioids between 1997-2010 and $S_{But-For}$ reflects average annual per capita shipments over this period excluding shipments estimated to result from defendants' misconduct, based on the estimate from the Rosenthal Report.[79] Based on these equations, the impact of defendants' actions on mortality for any year (T) can be calculated by multiplying the shipments coefficient β_1 by the difference between cumulative average actual shipments and the cumulative average "but for" shipments (**Table III.9**) as of year T.

108. **Table III.10** summarizes the estimated share of mortality attributable to prescription opioid shipments due to the defendants' misconduct in the average county for the years 2006-2010.[80] These results indicate that [redacted] percent of opioid mortality in 2010 is attributable to shipments resulting from defendants' misconduct. As discussed above, the direct model reflects a lower bound estimate of the impact of shipments on mortality. Even as a lower bound, however, this share is quite large.

[79] Alternatively, the impact of all shipments of prescription opioids, including those not attributable to defendants' misconduct, can be calculated by setting $S_{But-For}$ equal to zero (see **Appendix III.I**).

[80] The percent impact on mortality from the direct and indirect regressions is evaluated using the national average of 1997-2010 average shipments across the regression sample.

3. Licit Opioid Mortality from 2011 to 2016

109. For deaths post-2010 that are due to use of licit opioids only, the model above can be extended based on the difference between actual and but-for cumulative average shipments from 2011 through 2016. Specifically, given the estimated relationship between opioid shipments and deaths prior to 2010, it is reasonable to assume that this relationship can be applied to licit opioid deaths in the post-2010 period. Calculation of the impact of shipments on deaths due to licit opioids during this period involves the following steps and is reported in **Table III.11** below:

- First, the impact on mortality due to any opioid (both licit and illicit) from 2011 through 2016 is calculated by extending the calculation of the impact of shipments, as described

above and presented in **Table III.10**, using the cumulative average shipments for each year from 2011 through 2016 reported in **Table III.9**. Then, for each year, the percentage change in the impact of shipments relative to the impact calculated for the year 2010 is calculated, again for deaths due to either licit or illicit opioids (**Table III.11,** Columns E and F).

- "But for" deaths from licit opioids alone for 2010-16 are then estimated by first assuming that the percentage impact of shipments on deaths due to all opioids (25.9% as presented in **Table III.10** above) holds for licit opioids in 2010.[81] For the subsequent years 2011 through 2016, it is then assumed that the impact of shipments attributable to misconduct on deaths due to use of licit opioids grows at the same rate as the estimated impact for total opioid mortality using impact percentages relative to the year 2010, as presented in **Table III.11** Column H.
- The implied impact of shipments from this calculation is then used to estimate "but for" deaths due to licit opioids for 2011-2016, which in turn is used to calculate the share of deaths due to licit opioids that is attributable to shipments (**Table III.11** Column K).

110. The results of the calculations for mortality rates post-2010 presented in **Table III.11**, show that actual licit mortality was falling between 2011-2016 and that the share of licit mortality attributable to defendants' misconduct increased from 26.3 percent to 44.6 percent.[82]

[81] This assumption is conservative because, as discussed in the Gruber Report, nearly all of the increase in opioid mortality prior to 2010 is attributable to licit opioid mortality.
[82] The share of deaths due to licit opioid use attributable to misconduct over this time is growing because even through shipments per capita are falling after 2010, the cumulative average of shipments continues to grow

4. Illicit Opioid Mortality from 2011 to 2016

111. The impact of defendants' actions on deaths due to illicit opioids for the post-2010 period is based on an indirect regression specification, as described above, that estimates the determinants of the mortality rate due to illicit opioids in 2008-10 and uses these estimates to project the mortality rates due to illicit opioids based on changes in those determinants in 2011-2016.

112. In the absence of defendants' prior shipments of prescription opioids, a significant share of which are estimated to be attributable to misconduct, the number of people dependent on prescription opioids in 2010 would have been substantially reduced. Under these

through 2016. In addition, the percent of shipments attributable to defendants' misconduct continued to rise during this period, from 54.1% in 2010 to 61.6% in 2016 (Table III.9).

circumstances, the development of an abuse deterrent formulation of OxyContin and related regulatory and legal actions that contributed to reductions in prescription opioid shipments that led to the post-2010 increase in illicit opioids would not have occurred. As a result, increases in illicit opioid mortality relative to the benchmark implied by the indirect regression for illicit opioids after 2010 are appropriately attributed to defendants' misconduct. These results are summarized in **Table III.12**.

113. In order to implement this approach, but-for deaths due to illicit opioids in 2010 are first calculated based on the impact percentage estimated for all opioids in 2010 presented in **Table III.10**.[83] For the years 2011-2016, predicted mortality from illicit opioids is calculated by applying the year-by-year change in deaths due to illicit opioids implied by the indirect regression (**Table III.12** Column C). The difference between the actual and predicted mortality estimates is then calculated (**Table III.12** Column D) as well as the increment of this difference over the 2010 value (**Table III.12** Column E). Based on the analysis presented in Section V, the analysis then assumes that this growth in the difference between actual and predicted illicit mortality since 2010 is attributable to prescription opioid shipments. To determine the share of the growth in the difference between actual and predicted illicit mortality that is due to defendants' misconduct, the incremental difference in illicit mortality over the 2010 value is multiplied by the share of prescription opioid shipments that are attributable to defendants' misconduct (calculated by Prof. Rosenthal and reported in **Table III.12** Column F). The total incremental difference in illicit mortality due to defendants' misconduct is then calculated as

[83] This assumes that shipments had an equivalent percentage impact on illicit and prescription mortality.

the sum of (i) the estimated impact of defendants' misconduct on illicit mortality in 2010 and (ii) the share of the growth in the difference between actual and predicted illicit mortality that is due to defendants' misconduct. This is reported in **Table III.12** Column G. This in turn is expressed as a percentage to reflect the share of illicit opioids attributable to defendants' actions in each year between 2011-16 (**Table III.12** Column I).

114. As the table indicates, deaths due to illicit opioids grew by more than a factor of 3 over this period while predicted deaths (**Table III.12** Column C), estimated based on illicit opioid mortality patterns in the 2008-2010 time period declined. This in turn implies that the contribution to deaths due to illicit opioid mortality use due to defendants' misconduct grew to more than [redacted] of all illicit opioid mortality by 2016.

[redacted]

5. Percent of Harms Attributable to Defendants' Misconduct under Approach 1

115. **Table III.13** combines the results of estimated but-for opioid mortality from the direct analysis for 1997-2010 with the results of but-for mortality from the analyses regarding deaths due to licit and illicit opioids for 2011-2016, yielding year-specific estimates of but-for opioid mortality and the percentage of opioid mortality that is attributable to defendants' misconduct. The results indicate that the share of opioid mortality attributable to such misconduct grew from roughly [redacted].

B. Approach 2

116. Approach 2 calculates the share of opioid mortality due to defendants' shipments attributable to misconduct based on the indirect regression model that estimates the relationship between opioid mortality and the economic and demographic characteristics of counties over the 1993-95 time period. This analysis is based on the period before the launch of OxyContin and the subsequent acceleration in the growth of prescription opioid shipments, and thus yields estimates of opioid-related mortality rates that would have been expected to prevail in the absence of these events. Recognizing that the direct model yields only a lower bound estimate of the impact of shipments of prescription opioids on opioid-related mortality, application of the indirect approach based on the 1993-95 benchmark reflects the view that increases in opioid mortality not attributable to changes in economic and demographic factors can be attributed to the growth in shipments of prescription opioids.

117. The application of these results to estimate the share of opioid mortality attributable to defendants' misconduct is analogous to the application of the indirect model for illicit mortality

used in Approach 1. First, the "but for" estimate of opioid mortality is calculated based on the indirect regression using the economic and demographic characteristics in each year from 1996-2016 and the estimated relationship between these variables and opioid mortality in the 1993-95 time period. The difference between actual and "but for" mortality, expressed as a percentage of actual mortality, yields year-specific estimates of the share of actual mortality that is attributable to shipments. These estimates, in turn, are multiplied by the year-specific estimates of the share of past opioid shipments attributable to defendants' misconduct that are reported in the Rosenthal Report (see **Table III.9**). **Table III.14** presents these results below.

VII. Estimates of the Share of Harms faced By Bellwethers Resulting from Shipments Attributable to Defendants' Misconduct

118. This section reports estimates of the share of the various harms evaluated in Section IV above that result from shipments of prescription opioids that are attributable to defendants' misconduct. As explained in Section III, the share of harms attributable to defendants' misconduct can be expressed as follows:

$$\begin{aligned} &Share\ of\ Harms\ Attributable\ to\ Shipments\ Resuting\ from\ Defendants' Misconduct \\ &= \ Share\ of\ Harms\ Attributable\ to\ Opioids \\ &\quad * \ Share\ of\ Opioid\ Harms\ Attributable\ to\ Opioid\ Shipments \\ &\quad * \ Share\ of Opioid\ Shipments\ Due\ to\ Defendants' Misconduct \end{aligned}$$

119. The share of harms attributable to opioids is reported in Section IV above. The share of harms resulting from defendants' misconduct is reported in Section VI above, which combined the last two elements of the above formula. This section completes the analysis by combining these elements of the calculation, and the tables below report estimates of the share of harms resulting from shipments of prescription opioids that are attributable to defendants' misconduct for selected Bellwether divisions affected by the opioid crisis in each year from 2006-18.

120. Estimates are constructed by multiplying these two elements of the calculation. So, for example, the share of harms in the Cuyahoga Sheriff division in 2006 resulting from shipments attributable to defendants' misconduct is calculated in **Table III.15** below.

Table III.15
Example: Share of 2006 Harms to Cuyahoga Sheriff Division Due to Defendants' Misconduct

[a]	Share of Crime Attributable to Opioids	5.5%	Table III.4
[redacted]			
	Share of Crime Attributable to Defendants' Misconduct		
[d]=[a]*[b]	Approach 1	1.2%	
[e]=[a]*[c]	Approach 2	2.0%	

121. Data were not available to calculate the percentage of harm due to opioids (Section IV) for 2018 and the percentage of opioid harm due to prescription opioid shipments (Section VI) for 2017 through 2018. Therefore, when performing this calculation, these percentages are held constant in the later missing years. Since opioid mortality continued to increase after 2016, the estimates here are likely to understate the share of mortality that is attributable to shipments in those years.[84]

122. This approach assumes that opioid shipments due to defendants' misconduct have the same impact on harms as opioid shipments not due to this misconduct. There is no way to test this assumption, but there are good theoretical arguments why this assumption may understate the impact of misconduct on harms. Shipments not due to misconduct are likely to reflect those in true need, for example for people with end-stage cancer. If these individuals are not those who are typically posited as contributing to harms involving crime, police, foster care, addiction services and the like, then the shipments that are due to misconduct are more

[84]According to data from CDC Wonder, the number of opioid-related overdose deaths increased by more than 12% between 2016 and 2017, from 42,249 deaths in 2016 to 47,600 deaths in 2017.

likely to lead to harms than shipments not due to misconduct. Under this assumption, the estimates here on the contributions of defendants' misconduct to harm are understated.

123. **Tables III.16A** through **III.16B** below report the share of harms attributable to defendants' misconduct by Bellwether government, division, and year. Parallel tables that report: (1) the share of harms attributable to all shipments can be found in **Appendix III.I**; (2) the share of harms attributable to distributors' misconduct in **Appendix III.J**; and (3) the share of harms attributable to defendants' misconduct under Professor Rosenthal's indirect shipments regression method in **Appendix III.K**.

Table III.16A
County of Cuyahoga - Share of Harms Due to Defendants' Misconduct

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Approach 1													
ADAMHS Board	0.7%	0.9%	1 0%	1.0%	1.1%	1.2%	1.3%	2.6%	3.0%	4.0%	5.8%	6.7%	6.7%
DCFS	1.0%	1.2%	1.4%	1.7%	1.9%	2.0%	2.4%	3.3%	4.2%	5.0%	7.1%	7.5%	7.5%
Office of Prosecutor	1.2%	1.2%	1.7%	2.0%	2.5%	2.7%	3.2%	3.8%	3.9%	4.0%	4.3%	5.2%	5.2%
Office of Public Defender	1.2%	1.2%	1.7%	2.0%	2.5%	2.7%	3.2%	3.8%	3.9%	4.0%	4.3%	5.2%	5.2%
Court of Common Pleas	1.2%	1.3%	1.7%	2.1%	2.6%	2.8%	3.4%	4.0%	4.3%	4.4%	4.8%	5.8%	5.8%
Juvenile Court	0.3%	0.4%	0.6%	0.6%	0.6%	0.7%	0.8%	1.0%	1.4%	1.4%	2.1%	2.1%	2.1%
Sheriff's Office	1.2%	1.2%	1.7%	2.0%	2.5%	2.7%	3.2%	3.8%	3.9%	4.0%	4.3%	5.2%	5.2%
County Jail	1.2%	1.2%	1.7%	2.0%	2.5%	2.7%	3.2%	3.8%	3.9%	4.0%	4.3%	5.2%	5.2%
Office of Medical Examiner	1.9%	1.9%	2 8%	3.6%	4.4%	6.0%	7.1%	9.3%	10.1%	10.6%	18.1%	18.3%	18.3%
Approach 2													
ADAMHS Board	1.2%	1.5%	1.7%	1.5%	1.6%	1.6%	1.7%	3.0%	3.2%	4.1%	5.9%	6.7%	6.7%
DCFS	1.6%	2.0%	2.4%	2.5%	2.7%	2.9%	3.0%	3.8%	4.5%	5.1%	7.2%	7.6%	7.6%
Office of Prosecutor	2.0%	2.1%	2 8%	3.0%	3.5%	3.8%	4.1%	4.3%	4.2%	4.1%	4.4%	5.3%	5.3%
Office of Public Defender	2.0%	2.1%	2 8%	3.0%	3.5%	3.8%	4.1%	4.3%	4.2%	4.1%	4.4%	5.3%	5.3%
Court of Common Pleas	2.0%	2.1%	2 8%	3.1%	3.6%	4.0%	4.3%	4.6%	4.7%	4.5%	4.8%	5.9%	5.9%
Juvenile Court	0.6%	0.7%	0 9%	0.8%	0.9%	1.0%	1.0%	1.2%	1.5%	1.5%	2.1%	2.1%	2.1%
Sheriff's Office	2.0%	2.1%	2 8%	3.0%	3.5%	3.8%	4.1%	4.3%	4.2%	4.1%	4.4%	5.3%	5.3%
County Jail	2.0%	2.1%	2.8%	3.0%	3.5%	3.8%	4.1%	4.3%	4.2%	4.1%	4.4%	5.3%	5.3%
Office of Medical Examiner	3.2%	3.2%	4.7%	5.3%	6.3%	8.5%	8.9%	10.6%	11.0%	10 9%	18.3%	18.5%	18.5%

Table III.16B
County of Summit - Share of Harms Due to Defendants' Misconduct

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Approach 1													
ADM Board	0.4%	0.4%	0.5%	0.7%	1.5%	1.6%	2.7%	4.5%	5.3%	6.0%	7.3%	6.5%	6.5%
Children Services Board	0.9%	1.1%	1.5%	2.2%	5.7%	5.9%	7.7%	9.2%	10 0%	11.4%	14.5%	12.9%	12.9%
Prosecutor	1.1%	1.1%	1.5%	2.0%	2.1%	2.5%	3.1%	3.5%	4.1%	5.2%	5.6%	5.6%	5.6%
Court of Common Pleas	1.1%	1.1%	1.5%	2.0%	2.1%	2.5%	3.1%	3.5%	4.1%	5.2%	5.6%	5.6%	5.6%
Juvenile Court	0.6%	0.6%	0.8%	1.0%	1.1%	1.4%	1.7%	1.8%	2.2%	2.5%	3.2%	3.1%	3.1%
Sheriff's Office	1.1%	1.1%	1.5%	2.0%	2.1%	2.5%	3.1%	3.5%	4.1%	5.2%	5.6%	5.6%	5.6%
County Jail	1.2%	1.2%	1.6%	1.9%	2.3%	2.4%	2.9%	3.4%	3.8%	4.3%	4.5%	4.5%	4.5%
Alternative Corrections	1.2%	1.2%	1.6%	1.9%	2.3%	2.4%	2.9%	3.4%	3.8%	4.3%	4.5%	4.5%	4.5%
Adult Probation	1.1%	1.1%	1.5%	2.0%	2.1%	2.5%	3.1%	3.5%	4.1%	5.2%	5.6%	5.6%	5.6%
Medical Examiner	2.3%	2.3%	2.2%	3.2%	4.0%	3.5%	5.8%	5.8%	9.7%	12 2%	17.7%	15.2%	15.2%
Approach 2													
ADM Board	0.6%	0.7%	0.9%	1.0%	2.2%	2.2%	3.4%	5.2%	5.7%	6.2%	7.4%	6.6%	6.6%
Children Services Board	1.6%	1.9%	2.5%	3.2%	8.1%	8.4%	9.6%	10 5%	10 9%	11.7%	14.6%	13.0%	13.0%
Prosecutor	1.9%	1.9%	2.5%	2.9%	2.9%	3.6%	3.9%	4.0%	4.5%	5.4%	5.7%	5.7%	5.7%
Court of Common Pleas	1.9%	1.9%	2.5%	2.9%	2.9%	3.6%	3.9%	4.0%	4.5%	5.4%	5.7%	5.7%	5.7%
Juvenile Court	0.9%	1.0%	1.3%	1.4%	1.6%	2.0%	2.2%	2.1%	2.4%	2.6%	3.3%	3.1%	3.1%
Sheriff's Office	1.9%	1.9%	2.5%	2.9%	2.9%	3.6%	3.9%	4.0%	4.5%	5.4%	5.7%	5.7%	5.7%
County Jail	2.0%	2.1%	2.7%	2.8%	3.2%	3.4%	3.6%	3.8%	4.1%	4.4%	4.5%	4.5%	4.5%
Alternative Corrections	2.0%	2.1%	2.7%	2.8%	3.2%	3.4%	3.6%	3.8%	4.1%	4.4%	4.5%	4.5%	4.5%
Adult Probation	1.9%	1.9%	2.5%	2.9%	2.9%	3.6%	3.9%	4.0%	4.5%	5.4%	5.7%	5.7%	5.7%
Medical Examiner	3.9%	4.0%	3.7%	4.8%	5.7%	5.0%	7.3%	6.6%	10 5%	12.6%	17.8%	15.4%	15.4%

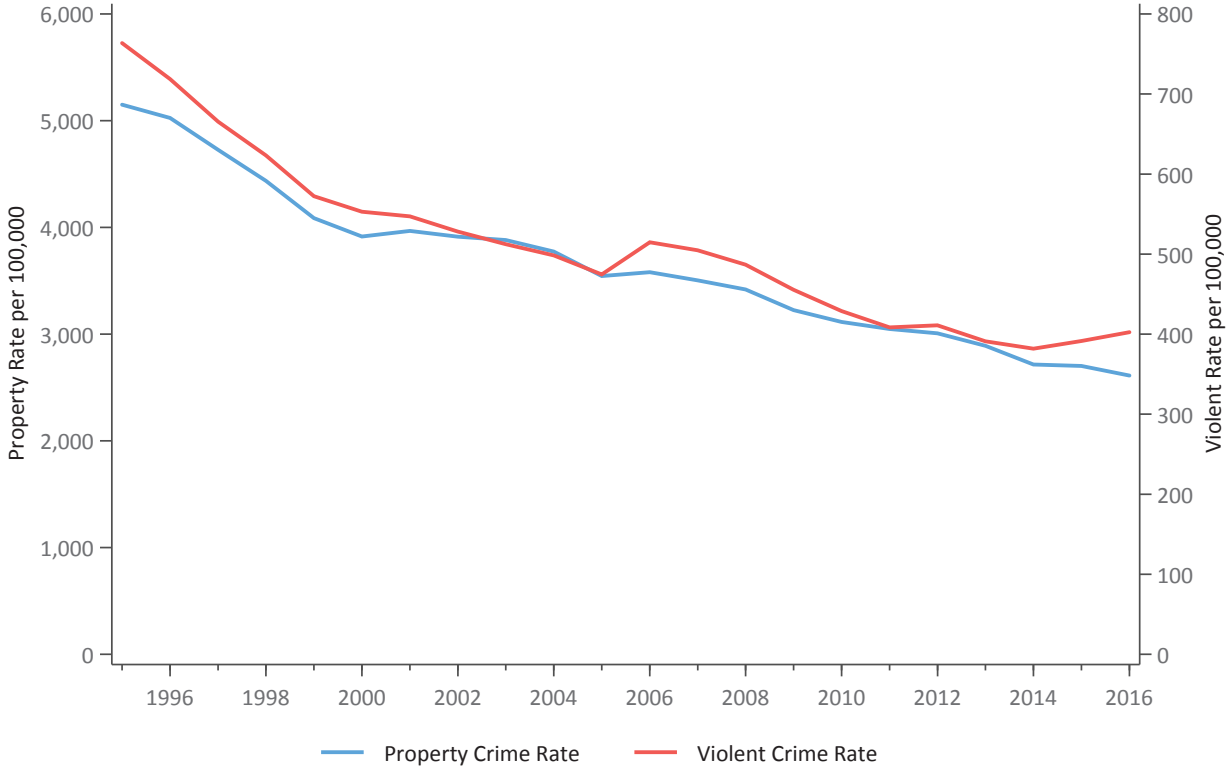
VIII. Supporting Analysis of Impact of Shipments on Crime

124. In the above analysis, the effect of prescription opioid shipments on various categories of harms are calculated using an approach which first estimates the percentage of harms due to opioids (or opioid misuse) and then the percentage of opioid misuse/harm due to shipments. This section presents a confirmatory analysis with regards to the effect of prescription opioid shipments on crime undertaken using a direct regression approach. Specifically, using data on crime rates and prescription opioid shipments at the county level, a statistical regression analysis is used to estimate the direct relationship between the defendants' shipments and crime. The results of this analysis confirm the effect of defendants' shipments on crime estimated using the primary approach discussed above.

A. Crime Trends

125. As noted in the Gruber Report, crime rates have been falling since their peak in the 1990s.[85] This is confirmed in **Figure III.7** below which shows that both property and violent crime rates have fallen substantially over this time period.

Figure III.7
Historical Property and Violent Crime Rates



Source: FBI and Census Data.

126. Similarly, it has also been documented that the rate of decline in crime has been greater in areas where crime rates were initially higher, with historically high crime cities such as New

[85] See, e.g. Friedman, Matthew, Ames C. Grawert, and James Cullen. *Crime Trends, 1990-2016*. New York, NY: Brennan Center for Justice at New York University School of Law, 2017.

York realizing the greatest reductions in crime over time.[86] The specification of the regression model used to evaluate the impact of shipments on crime accounts for this by controlling for the crime rate in the initial period in each county as an independent variable in the regression analysis. This specification follows that used in the direct regression analysis of changes in mortality over time, which includes mortality in the initial period as an independent variable.

B. Regressions Estimating Impact of Shipments on Crime

127. To estimate the size of the impact of prescription opioid shipments on crime, the general long difference regression framework (as described above) was used, tailored to the estimation of the effect on crime. This section describes the calculation of the crime regression-specific variables used in this regression, including the dependent variable, the county crime rate, and the additional control variables.

1. Calculation of Crime Rates

128. To estimate the annual share of crimes due to opioid shipments, the regression analysis estimates the effect of average shipments on crime rates (which are calculated as the number of reported crime incidents per 100,000 population). (See the attached **Data Appendix** for a detailed description on the data used to calculate crime rates by county). Note that the analysis examines changes in the rates of crime incidence and does not evaluate the effect of

[86] See Levitt, Steven D. "Understanding why crime fell in the 1990s: Four factors that explain the decline and six that do not." Journal of Economic Perspectives 18, no. 1 (2004): 163-190 ("Levitt (2004)") at p. 167 noting that: "The greatest percentage improvements in crime occurred within metropolitan statistical areas (MSAs) and especially among large cities with populations over 250,000. Rural areas, particularly on violent and property crime, saw much smaller declines in both absolute terms and percentage terms. For instance, the homicide rate per 100,000 residents in large cities fell 12.9 per 100,000 (from 26.2 to 13.3). The decline in homicide rates for cities with populations less than 50,000 was only 1.5 (from 4.3 to 2.8)." See also, Levitt (2004), Table 4.

opioid shipments on arrests or convictions, as these outcomes reflect other factors beyond just crimes committed, including the efficiency of the judicial system and the general conduct and policies of the police force in an area.

129. Crimes are generally divided into three groups: property crime (examples include burglary, larceny, and theft), violent crime (examples include murder and assault), and crimes against society (which includes drug crimes). As discussed in the attached **Data Appendix**, incidents for crimes against society are not reported in the FBI data as these crimes are typically not reported to police due to the "victimless" nature of these incidents. As a result, these regressions cannot evaluate the effect of shipments on drug crime rates (or crime rates for any other crimes against society such as prostitution or weapons trafficking).

130. There is no sudden shift in crime rates in 2010 the way that there is in opioid-related mortality rates. This is to be expected since overall trends in property and violent crime are a product of many factors, only one of which is opioid use. Thus, the models for crime estimate the change in crime rates over the entire time period, from 1995-2016, and do not distinguish between the pre- and post-2010 period.

2. Independent Variables

131. The same measure of shipments as used in the direct impact regression mortality described above is employed here. That is, per capita shipments are calculated using ARCOS data on shipments of prescription opioids between 1997 (the first year for which data are available) and 2010, the last year prior to the shift in the opioid marketplace, and are expressed in terms of average MMEs per person per day.

132. In addition to the crime rate in 1995-96, additional control variables include economic and demographic factors whose effect on crime has previously been studied, are included in the regression.[87] These variables, which are described in more detail in the discussion of the direct mortality regression above, are included in levels and changes, the same as in the direct mortality regression.

C. Results

133. The regression results are reported in **Appendix III.L**. The coefficients on the economic and demographic variables show results that are common in the literature. Specifically, all else equal, crime tends to be higher in areas with a larger population of younger people, men, and in areas where economic outcomes are worse. For both property and violent crime, the regressions show a positive and statistically significant relationship between opioid shipments to a county and the changes in the incidence of crime between 1995-96 and 2015-16. That is, all else equal, crime fell less in areas with larger opioid shipments, even controlling for demographic and economic changes. Based on these equations, the impact of defendants' actions on crime for 2016 can be calculated using the same method as was implemented for the direct mortality regression. That is, the shipments coefficient estimated in the regression is multiplied by the implied but-for average shipments over the 1997 to 2010 period to estimate

[87] See, e.g., Gould, Eric D., Bruce A. Weinberg, and David B. Mustard. "Crime rates and local labor market opportunities in the United States: 1979–1997." *Review of Economics and statistics* 84 (2002): 45-61; Perkins, Craig A. Age patterns of victims of serious violent crime. US Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, 1997; Freeman, Richard B. "The economics of crime." *Handbook of labor economics 3* (1999): 3529-3571; and Leavitt (2004).

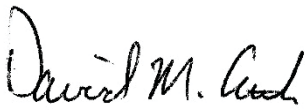
the effect in 2016.[88] This is calculated for property crime, violent crime, and the total of property crime and violent crime, as the latter is a closer metric to the crime calculations reported in **Tables III.16A and B** above (in which the estimated effect of the defendants' misconduct on all crimes is reported). **Table III.17** summarizes these results. As can be seen from the table below, the crime regression suggests that in 2016, 7.9 percent of crime is attributable to defendants' misconduct, whereas the analysis above for the Cuyahoga and Summit Sheriff departments estimates this to be between 4.3 – 5.7 percent. Thus, the crime regression analysis confirms the earlier conclusions suggesting, if anything, that the results above are conservative.

Table III.17
Increase in Crime due to Defendants' Misconduct
2016

Crime Regression Approach			Analysis of Crime-Related Harms Under:			
			Approach 1		Approach 2	
Property	Violent	Property and Violent	Cuyahoga Sheriff	Summit Sheriff	Cuyahoga Sheriff	Summit Sheriff
7.6%	9.9%	7.9%	4.3%	5.6%	4.4%	5.7%

[88] For the purpose of this example calculation it is assumed that the coefficient for 2016 is the same as the coefficient that is estimated in the regression, which is based on using the average crime rate between 2015 and 2016 as the post-period.

March 25, 2019



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David Cutler

Appendix III.A: Curriculum Vitae

David M. Cutler

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Website

Employment

2014-: Harvard College Professor, Harvard University

2005-: Otto Eckstein Professor of Applied Economics, Department of Economics and Kennedy School of Government, Harvard University

2003-2008: Social Sciences Dean, Faculty of Arts and Sciences, Harvard University

1997-2005: Professor of Economics, Department of Economics and Kennedy School of Government, Harvard University

1995-1997: John L. Loeb Associate Professor of Social Sciences, Harvard University

1993: On leave as Senior Staff Economist, Council of Economic Advisers and Director, National Economic Council

1991-1995: Assistant Professor of Economics, Harvard University

Other Affiliations

Academic and Policy Advisory Board, Kyruss, Incorporated

National Advisory Board, Firefly

Board Member, Center for Healthcare Transparency

Consultant, Mathematica Policy Research, Inc.

Consultant, Mercer Health & Benefits, LLC

Fellow, Employee Benefit Research Institute

Litigation. Retained by counsel for plaintiffs to provide expert services in pending litigation involving opioid pharmaceuticals.

Member, Institute for Research on Poverty

Member, Institute of Medicine

Member, National Academy of Social Insurance

Research Associate, National Bureau of Economic Research, Aging, Health Care, Public Economics, and Productivity programs

Scientific Advisory Board, Alliance for Aging Research

Scientific Advisory Board, F-Prime Capital Partners (formerly Scientific Advisory Board, Fidelity Investments)

Senior Fellow, Center for American Progress

Public Service

2012-: Health Policy Commission, Commonwealth of Massachusetts

2006-2012: Group Insurance Commission, Commonwealth of Massachusetts

2002: Institute of Medicine Panel, "Vaccine Purchase Strategies in the United States"

2001: Institute of Medicine Panel, Priority Areas for Quality Improvement"

2000: Medicare Technical Advisory Panel

1999: National Academy of Sciences Panel, New Horizons in Health: An Integrative Approach

1998: National Academy of Sciences Panel, Scientific Opportunities and Public Needs: Improving Priority Setting and Public Input at the National Institutes of Health

1998-2002: National Institutes of Health Study Section Reviewer

1994-95: Technical Panel, Advisory Council on Social Security

1993: Senior Economist, Council of Economic Advisors, and Director, National Economic Council.

Honors and Awards

2018: Carpenter Award, Babson College

2014: Harvard College Professor, Harvard University

2011: MetLife Silver Scholar Award, Alliance for Aging Research

2011: Distinguished Leadership Award, Center for Connected Health, Partners Health Care

2009: John P. McGovern Award from the Association of Academic Health Centers

2007: Elected to American Academy of Arts and Sciences

2007: Named one of the 50 most influential men under age 45 by *Details* magazine

2006: Named one of "30 For The Future" by *Modern Healthcare* magazine, August 2006

2006: Biennial award for distinguished contribution to the literature in population, Section on the Sociology of Population of the American Sociological Association, for "The Role of Public Health Improvements in Health Advances: The 20th Century United States"

2006: American Society of Health Economists Medal, Outstanding Health Economist Age 40 and Under

2004: David Kershaw Prize, Association for Public Policy and Management

2004: John Eisenberg Mentoring Award, Agency for Health Care Quality and Research

2003: Eugene Garfield Award, Research!America, for "The Return to Biomedical Research: Treatment and Behavioral Effects"

2001: Elected to Institute of Medicine

2000: Kenneth Arrow Award, Best Paper in Health Economics, for "How Does Managed Care Do It?"

2000-2001: Fellow, Center for Advanced Study in Behavioral Sciences

1999: Griliches Prize, best paper in *Quarterly Journal of Economics*, for "Are Medical Prices Declining?"

1999: Outstanding Mentor Award, Harvard University Graduate School of Arts and Sciences

1991: Honorable Mention, Outstanding Dissertation, National Academy of Social Insurance

1987: Phi Beta Kappa

Education

Ph.D. (Economics), M.I.T., September 1991.

A.B. (Economics, Summa Cum Laude) Harvard, 1987.

Professional Service

Former Member, Board of Directors, International Health Economics Association

Former Editor, *Journal of Health Economics*

Former Associate Editor, *Journal of Economic Perspectives*

Former Associate Editor, *Journal of Public Economics*

Former Associate Editor, *World Health Organization Bulletin*

Research Funding

Commonwealth Foundation

Kaiser Family Foundation

Lasker Foundation

Pfizer

Pharmaceutical Research and Manufacturers Association

Robert Wood Johnson Foundation

Russell Sage Foundation

Rx Foundation

Alfred P. Sloan Foundation

U.S. Agency for Health Care Policy and Research

U.S. Department of Labor

U.S. National Institute of Health

U.S. Social Security Administration

Primary Fields

Health Economics

Public Economics

Books

Your Money or Your Life: Strong Medicine for America's Health Care System, Oxford University Press, 2004.

The Quality Cure: How Focusing on Health Care Quality Can Save Your Life and Lower Spending Too, University of California Press, 2014.

Edited Books

The Changing Hospital Industry: Comparing Not-for-Profit and For-Profit Hospitals, Chicago: University of Chicago Press, 1999.

Medical Care Output and Productivity, Chicago: University of Chicago Press, 2001 (with Ernst Berndt).

Frontiers in Health Policy Research, Volume 6, online as *Forum for Health Economics and Policy*, 2003 (with Alan Garber).

Frontiers in Health Policy Research, Volume 7, online as *Forum for Health Economics and Policy*, 2004 (with Alan Garber).

Frontiers in Health Policy Research, Volume 8, online as *Forum for Health Economics and Policy*, 2005 (with Alan Garber).

Frontiers in Health Policy Research, Volume 9, online as *Forum for Health Economics and Policy*, 2006 (with Alan Garber and Dana Goldman).

Frontiers in Health Policy Research, Volume 10, online as *Forum for Health Economics and Policy*, 2007 (with Alan Garber and Dana Goldman).

Health at Older Ages: The Causes and Consequences of Declining Disability Among the Elderly, University of Chicago Press, 2009 (with David Wise).

Measuring and Modeling Health Care Costs, Chicago: University of Chicago Press, 2018 (with Ana Aizcorbe, Colin Baker, and Ernst Berndt).

Articles

"Explaining The Slowdown In Medical Spending Growth Among The Elderly, 1999–2012," *Health Affairs* 38 (2), February 2019, 222-229 (with Kaushik Ghosh, Kassandra L. Messer, Trivellore E. Raghunathan, Susan T. Stewart, and Allison B. Rosen).

"The Contribution Of New Product Entry Versus Existing Product Inflation In The Rising Costs Of Drugs" *Health Affairs* 38 (1), January 2019, 76-83 (with Inmaculada Hernandez, Chester B. Good, Walid F. Gellad, Natasha Parekh, and William H. Shrank)

"Physician Beliefs and Patient Preferences: A New Look at Regional Variation in Health Care Spending," *American Economic Journal: Economic Policy,* 11(1) February 2019, 192-221. (with Jonathan Skinner, Ariel Dora Stern, and David Wennberg).

"Factors of U.S. Hospitals Associated with Improved Profit Margins: An Observational Study" *Journal of General Internal Medicine*, 33(7), July 2018, 1020-1027 (with Dan Ly).

"What Is The US Health Spending Problem?" *Health Affairs*, 37(3), March 2018, 493-497.

"Introduction to Measuring and Modeling Health Care Costs" in *Measuring and Modeling Health Care Costs,* 2018 (Ana Aizcorbe, Colin Baker, Ernst Berndt, and David Cutler, editors).

"Attribution of Health Care Costs to Diseases: Does the Method Matter?" in *Measuring and Modeling Health Care Costs,* 2018 (Ana Aizcorbe, Colin Baker, Ernst Berndt, and David Cutler, editors).

"The IT Transformation Health Care Needs" *Harvard Business Review*, 95(6), November 2017, 129-136 (with Nikhil Sahni, Robert Huckman, Anuraag Chigurupati).

"Business Resilience and Energy Innovation" *Harvard Business Review*, 95(6), November 2017, 137-138 (with Nikhil Sahni, Robert Huckman, Anuraag Chigurupati).

"Potential Impact of Affordable Care Act-Related Insurance Expansion on Trauma Care Reimbursement" *Journal of Trauma and Acute Care Surgery*, 82(5), May 2017, 887-895 (with John W. Scott, Pooja U. Neiman, Peter A. Najjar, Thomas C. Tsai, Kirstin W. Scott, Mark G. Shrime, Ali Salim, and Adil H. Haider).

"Teaching Health Care in Introductory Economics" *Journal of Economic Education*, 48(3), May 2017, 218-223.

"Where Do Freestanding Emergency Departments Choose to Locate? A National Inventory and Geographic Analysis in Three States," *Annals of Emergency Medicine*, 69(4), April 2017, 383-392 (with Jeremiah D. Schuur, Olesya Baker, Jaclyn Freshman, and Michael Wilson).

"Early Death After Discharge from Emergency Departments: Analysis Of National US Insurance Claims Data," *British Medical Journal*, 356(j239), February 2017, 1-9, (with Ziad Obermeyer, Brent Cohn, Michael Wilson, and Anupam B Jena).

"State Regulation of Freestanding Emergency Departments Varies Widely, Affecting Location, Growth, and Services Provided," *Health Affairs*, 35 (10), October 2016, 1857-1866 (with Catherine Gutierrez, Rachel A. Lindor, Olesya Baker, and Jeremiah D. Schuur).

"Changes in Hospital–Physician Affiliations in U.S. Hospitals and Their Effect on Quality of Care," *Annals of Internal Medicine*, 166(1) January 2017, 1-9 (with Kirstin W. Scott, E. John Orav, and Ashish K. Jha).

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"Surgeon Specialization and Operative Mortality in United States: Retrospective Analysis," *British Medical Journal*, 354 (i3571), June 2016, 1-9 (with Nikhil Sahni, Maurice Dalton, John Birkmeyer, and Amitabh Chandra).

"Understanding the Improvement in Disability Free Life Expectancy in the U.S. Elderly Population," in David Wise, ed., *Insights in the Economics of Aging,* Chicago: University of Chicago Press, 2017 (with Michael Chernew, Kaushik Ghosh, and Mary Beth Landrum).

"Short-term Outcomes for Medicare Beneficiaries After Low-acuity Visits to Emergency Departments and Clinics," *Medical Care*, 54 (5), May 2016, 498-503 (with Katherine Baicker, Matthew J. Niedzwiecki, Ziad Obermeyer, and Michael Wilson).

"The Association Between Income and Life Expectancy in the United States, 2001-2014," *JAMA*, 315(16), April 2016, 1750-66 (with Raj Chetty, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, and Augustin Bergeron).

"Economic Approaches to Estimating Benefits of Regulations Affecting Addictive Goods," *American Journal of Preventative Medicine*, 50 (5S1), May 2016, S20–S26 (with Amber I. Jessup, Donald S. Kenkel, and Martha A. Starr).

"Emergency Care Use and the Medicare Hospice Benefit for Individuals with Cancer with a Poor Prognosis," *Journal of the American Geriatric Society*, 64(2) January 2016, 323-329 (with Ziad Obermeyer, Alissa C. Clarke, Maggie Makar, and Jeremiah D. Schuur).

"Association of Influenza Vaccination Coverage in Younger Adults with Influenza-Related Illness in the Elderly," *Clinical Infectious Diseases*, 61(10), November 2015, 1495-1503 (with Glen B. Taksler and Michael B. Rothberg).

"Valuing Regulations Affecting Addictive or Habitual Goods," *Journal of Benefit-Cost Analysis* 6(2), June 2015, 247-280.

"Physician Characteristics Strongly Predict Patient Enrollment in Hospice," *Health Affairs*, 34(6), June 2015, 993-1000.

"Recent National Trends in Acute Myocardial Infarction Hospitalizations in Medicare: Shrinking Declines and Growing Disparities," *Epidemiology*, 26(4), July 2015, e46-e47 (with Naomi C. Sacks, Arlene S. Ash, Kaushik Ghosh, Amy K. Rosen, John B. Wong, and Allison B. Rosen).

"Cost Savings Associated with Expanded Hospice Use in Medicare," *Journal of Palliative Medicine*, 18(5), May 2015, 400-401 (with Brian W. Powers, Maggie Makar, Sachin H. Jain, and Ziad Obermeyer).

"Cost-Effectiveness of Multiplexed Predictive Biomarker Screening in Non-Small-Cell Lung Cancer," *Journal of Thoracic Oncology*, 10(4), April 2015, 586-594 (with Dorothy Romanus, Stephanie Cardarella, Mary Beth Landrum, Scott Gazelle).

"Vitamin D Deficiency in Minority Populations," *Public Health Nutrition*, 8(3), February 2015, 379-391 (with Glen B. Taksler, Edward Giovannucci, and Nancy L. Keating).

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"Who Pays for Public Employee Health Costs?" *Journal of Health Economic,* 38, December 2014, 65-76, (with Jeffrey Clemens).

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"Association between the Medicare Hospice Benefit and Health Care Utilization and Costs for Patients with Poor-prognosis Cancer," *JAMA*, 312(18), October 2014, 1888-1896 (with Ziad Obermeyer, Maggie Makar, Samer Abujaber, Francesca Dominici, and Susan Block).

"Hospital and Emergency Department Factors Associated with Variations in Missed Diagnosis and Costs for Patients Age 65 Years and Older with Acute Myocardial Infarction Who Present to Emergency Departments," *Academic Emergency Medicine,* 21(10), October 2014, 1101-1108 (with Michael Wilson, Jonathan Welch, Jeremiah Schuur, and Kelli O'Laughlin).

"Comparison of Trends in US Health-Related Quality of Life Over the 2000s Using the SF-6D, HALex, EQ-5D, and EQ-5D Visual Analog Scale Versus a Broader Set of Symptoms and Impairments," *Medical Care,* 52(12), December 2014, 1010-1016 (with Susan T. Stewart and Allison B. Rosen).

"Trends in Stroke Rates, Risk, and Outcomes in the United States, 1988 to 2008," *American Journal of Medicine,* 127(7), July 2014, 608-615 (with Margaret C. Fang, Marcelo Coca Perraillon, Kaushik Ghosh, and Allison B. Rosen).

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"Health Care Spending—A Giant Slain or Sleeping?" *New England Journal of Medicine*, 369(26), December 2013, 2551-2557 (with David Blumenthal and Kris Stremikis).

"Hospitals, Market Share, and Consolidation," *JAMA*, 310(18), November 2013, 1964-1970 (with Fiona Scott Morton).

"US Trends in Quality-Adjusted Life Expectancy From 1987 to 2008: Combining National Surveys to More Broadly Track the Health of the Nation," *American Journal of Public Health*, 103(11) November 2013, e78-e87 (with Susan Stewart and Allison B. Rosen).

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"Ultraviolet Index and Racial Differences in Prostate Cancer Incidence and Mortality," *Cancer,* 119(17) September 2013, 3195-203 (with Glen B. Taksler, Edward Giovannucci, Matthew R. Smith, and Nancy L. Keating).

"If Slow Rate Of Health Care Spending Growth Persists, Projections May Be Off By $770 Billion," *Health Affairs*, 32(5) May 2013, 841-850 (with Nikhil Sahni).

"Policy Makers Will Need A Way To Update Bundled Payments That Reflects Highly Skewed Spending Growth Of Various Care Episodes," *Health Affairs*, 32(5) May 2013, 944-951 (with Allison B. Rosen, Ana Aizcorbe, Alexander J. Ryu, Nicole Nestoriak, and Michael E. Chernew).

"Mortality Reduction among Pneumonia Patients Still Substantial despite the Impact of Coding Changes," *American Journal of Medicine*, 126(3), March 2013, 266-269 (with Gregory Ruhnke and Marcelo Coca Perraillion).

"Dimensions of Health in the Elderly Population," in Wise, David A. *Investigations in the Economics of Aging,* Chicago: University of Chicago Press, 2012 (with Mary Beth Landrum).

"Paper Cuts: Reducing Health Care Administrative Costs," *Center for American Progress*, June 2012 (with Elizabeth Wikler and Peter Basch).

"Induced Innovation and Social Inequity Evidence from Infant Medical Care," *Journal of Human Resources*, 47(2), Spring 2012, 456-492 (with Ellen Meara and Seth Shubik-Richards).

"Explaining Racial Differences in Prostate Cancer Mortality," *Cancer*, January 13, 2012 (with Glenn Taksler and Nancy Keating).

"Education And Health: Insights from International Comparisons" NBER Working Paper 17738, January 2012 (with Adriana Lleras-Muney).

"Rising Educational Gradients in Mortality: The Role of Behavioral Risk Factors" *Journal of Health Economics*, 30(6), December 2011, 1174-87 (with Fabian Lange, Ellen Meara, Seth Richards-Shubik, and Christopher J. Ruhm).

"The Overuse of Antidepressants in a Nationally Representative Adult Patient Population in 2005" *Psychiatric Services*, 62(7), July 2011, 720-726 (with Alisa B. Busch and Rena Conti).

"The (Paper) Work of Medicine: Understanding International Medical Costs" *Journal of Economic Perspectives*, 30(6), Spring 2011, 1174-87 (with Dan P. Ly).

"Marked Reduction in 30-day Mortality among Elderly Patients with Community-Acquired Pneumonia" *American Journal of Medicine*, 124(2), February 2011, 171-178 (with Greg Ruhnke, Marcelo Coca-Perraillon, and Barrett T. Kitch).

"Trends In Mortality and Medical Spending in Patients Hospitalized For Community-Acquired Pneumonia: 1993-2005" *Medical Care,* 48(12), December 2010, 1111-1116 (with Greg Ruhnke, Marcelo Coca-Perraillon, and Barrett T. Kitch).

"Cost-Effectiveness Analysis in Markets With High Fixed Costs" *Pharmacoeconomics*, 26(10), October 2010, 867-875 (with Keith Ericson).

"Trends in Thrombolytic Use for Ischemic Stroke in the United States" *Journal of Hospital Medicine*, 5(7), September 2010, 406-409 (with Margaret Fang and Allison Rosen).

"Selection Stories: Understanding Movement Across Health Plans" *Journal of Health Economics*, 29(5), September 2010, 821-838 (with Bryan Lincoln and Richard Zeckhauser).

"Medical Spending Differences in the United States and Canada: The Role of Prices, Procedures, and Administrative Costs" *Inquiry*, 47(2), Summer 2010, 124-134 (with Alexis Pozen).

"Where Are the Health Care Entrepreneurs?" *Issues in Science and Technology*, 27(1), July 2010, 49-56.

"The Impact of Health Reform on Health System Spending" *Commonwealth Fund Issue Brief,* May 2010 (with Karen Davis and Kristof Stremikis).

"Early Life Malaria Exposure and Adult Outcomes: Evidence from Malaria Eradication in India" *American Economic Journal: Applied Economics*, 2(2), April 2010, 196-202 (with Winnie Fung, Michael Kremer, Monica Singhal, and Tom Vogl).

"Patient, Physician, and Payment Predictors of Statin Adherence" *Medical Care*, 48(3), March 2010, 196-202 (with David C. Chan, William H. Shrank, Saira Jan, Michael A. Fischer, Jun Liu, Jerry Avorn, Daniel Solomon, M. Alan Brookhart, and Niteesh K. Choudhry).

"Input Constraints and the Efficiency of Entry: Lessons from Cardiac Surgery" *American Economic Journal: Economic Policy*, 2(1), February 2010, 51-76 (with Robert Huckman and Jonathan Kolstad).

"Workplace Wellness Programs Can Generate Savings" *Health Affairs*, 29(2), February 2010, 1-8 (with Katherine Baicker and Zirui Song).

"Understanding Differences in Health Behavior by Education" *Journal of Health Economics*, 29(1), January 2010, 1-28 (with Adriana Lleras-Muney).

"The Education Gradient in Old Age Disability" in David Wise, ed., *Research Findings in the Economics of Aging*, Chicago: University of Chicago Press, 2010, 101-120 (with Adriana Lleras-Muney).

"Social Interactions and Smoking" in David Wise, ed., *Research Findings in the Economics of Aging*, Chicago: University of Chicago Press, 2010, 123-141 (with Edward Glaeser).

"Adoption and Spread of New Imaging Technology: A Case Study" *Health Affairs,* 28(6), November/December 2009, w1122-1132 (with Joseph Ladapo, Jill Horwitz, Milt Weinstein, and Scott Gazelle).

"Clinical Outcomes and Cost-Effectiveness of Coronary Computed Tomography Angiography in the Evaluation of Patients with Chest Pain" *Journal of the American College of Cardiology,* 54(25), December 15, 2009, 2409-2422 (with Joseph Ladapo, Farouc Jaffer, Udo Hoffmann, Carey Thomson, Fabian Bamberg, William Dec, Milt Weinstein, and Scott Gazelle).

"Forecasting the Effects of Obesity and Smoking on U.S. Life Expectancy" *New England Journal of Medicine*, 361, December 2, 2009, 2252-2260 (with Susan Stewart and Allison Rosen).

"Incidence and Mortality of Hip Fractures in the United States" *JAMA*, 302(14), 2009, 1573-1579 (with Carmen Brauer, Marcelo Coca-Perraillon and Allison B. Rosen).

"The Benefits of Risk Factor Prevention in Americans Aged 51 and Older" *American Journal of Public Health*, 99(11), 2009, 2096-2101 (with Dana Goldman, Yuhui Zheng, Federico Girosi, Pierre-Carl Michaud, S. Jay Olshansky, and John W. Rowe).

"Changes in the Incidence and Duration of Periods Without Insurance" *New England Journal of Medicine*, 360(17), 2009, 1740-1748 (with Alex Gelber).

"Challenges in Building Disease-Based National Health Accounts" *Medical Care*, 47(7), July 2009, Supplement 1, S7-S13 (with Allison B. Rosen).

"Why Do Europeans Smoke More Than Americans?" in David Wise, ed., *Developments in the Economics of Aging*, Chicago: University of Chicago Press, 2009 (with Edward Glaeser).

"How Do The Better Educated Do It? Socioeconomic Status and Ability to Cope with Underlying Impairment" in David Wise, ed., *Developments in the Economics of Aging*, Chicago: University of Chicago Press, 2009 (with Mary Beth Landrum and Kate Stewart).

"Clinical Pathways to Disability" in David Cutler and David Wise, eds., *Health at Older Ages: The Causes and Consequences of Declining Disability Among the Elderly,"* Chicago: University of Chicago Press, 2009 (with Mary Beth Landrum and Kate Stewart).

"Intensive Medical Care and Cardiovascular Disease Disability Reductions" in David Cutler and David Wise, eds., *Health at Older Ages: The Causes and Consequences of Declining Disability Among the Elderly,"* Chicago: University of Chicago Press, 2009 (with Mary Beth Landrum and Kate Stewart).

"Is The U.S. Population Behaving Healthier?" in Jeffrey R. Brown, Jeffrey Liebman, and David Wise, *Social Security Policy in a Changing Environment*, 2009 (with Edward Glaeser and Allison B. Rosen).

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"Are We Finally Winning the War on Cancer?" *Journal of Economic Perspectives*, 22(4), Fall 2008, 3-26.

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Data Sources

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David Cutler has not testified as an expert at trial or by deposition in the previous four years.

Appendix III.C: Opioid-Related Percent of Criminal Activity

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APPENDIX III.C.1
Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF CHARGES (Prosecutor / Public Defender / Sheriff)													
[1]	Total Charges Related to Drugs	20,894	20,074	19,254	18,434	18,748	17,608	16,681	16,210	15,403	13,537	14,116	15,266
[2]	Total Charges	61,388	59,589	57,790	55,992	57,146	54,348	51,219	50,673	53,887	53,885	54,588	50,955
[3]	**Drug-Related % of Charges**	**34.0%**	**33.7%**	**33.3%**	**32.9%**	**32.8%**	**32.4%**	**32.6%**	**32.0%**	**28.6%**	**25.1%**	**25.9%**	**30.0%**
[4]	Total Charges Related to Opioids	3,400	3,273	4,146	4,700	5,482	5,265	5,044	5,097	5,052	4,707	4,942	5,584
[5]	Total Charges Related to Drugs	20,894	20,074	19,254	18,434	18,748	17,608	16,681	16,210	15,403	13,537	14,116	15,266
[6]	**Opioid % of Drug-Related Charges**	**16.3%**	**16.3%**	**21.5%**	**25.5%**	**29.2%**	**29.9%**	**30.2%**	**31.4%**	**32.8%**	**34.8%**	**35.0%**	**36.6%**

Sources & Notes:
[1]=Panel C2[27].
[2]=Panel C1[29].
[3]=[1]/[2].
[4]=Panel C3[27].
[5]=[1].
[6]=[4]/[5].

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL B - OPIOID-RELATED % OF ADULT CHARGES (Court of Common Pleas / Jail)													
[1]	Total Adult Charges Related to Drugs	20,277	19,476	18,674	17,873	18,157	16,979	15,912	15,023	13,585	11,680	12,161	13,579
[2]	Total Adult Charges	57,797	56,091	54,386	52,680	53,721	50,335	46,166	43,335	42,315	41,853	42,390	40,823
[3]	**Drug-Related % of Adult Charges**	**35.1%**	**34.7%**	**34.3%**	**33.9%**	**33.8%**	**33.7%**	**34.5%**	**34.7%**	**32.1%**	**27.9%**	**28.7%**	**33.3%**
[4]	Total Adult Charges Related to Opioids	3,268	3,145	3,982	4,533	5,294	5,063	4,774	4,684	4,417	4,041	4,240	4,967
[5]	Total Adult Charges Related to Drugs	20,277	19,476	18,674	17,873	18,157	16,979	15,912	15,023	13,585	11,680	12,161	13,579
[6]	**Opioid % of Drug-Related Adult Charges**	**16.1%**	**16.1%**	**21.3%**	**25.4%**	**29.2%**	**29.8%**	**30.0%**	**31.2%**	**32.5%**	**34.6%**	**34.9%**	**36.6%**

Sources & Notes:
[1]=Panel D2[27].
[2]=Panel D1[29].
[3]=[1]/[2].
[4]=Panel D3[27].
[5]=[1].
[6]=[4]/[5].

APPENDIX III.C.1
Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C1 - CRIMINAL CHARGES BY OFFENSE TYPES													
[1]	Aggravated Assault	3,397	3,344	3,292	3,239	3,554	3,308	3,269	2,865	3,148	3,473	3,421	3,139
[2]	All Other Offenses	17,385	16,890	16,395	15,900	17,255	15,909	15,439	14,876	17,093	18,205	18,181	16,020
[3]	Arson	298	288	278	268	302	362	190	224	182	183	253	296
[4]	Burglary	3,117	3,010	2,903	2,796	3,275	3,139	2,985	2,897	2,868	2,947	3,224	2,534
[5]	Curfew/Loitering/Vagrancy	0	0	0	0	0	0	0	1	6	14	15	3
[6]	Disorderly Conduct	69	70	71	72	54	44	68	129	227	156	181	159
[7]	Driving Under the Influence	2	37	73	108	112	111	95	134	165	281	276	415
[8]	Drug Crimes	14,581	13,951	13,321	12,691	13,022	12,027	11,347	10,828	9,853	7,890	8,200	10,274
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	1,540	1,448	1,357	1,265	1,099	1,361	1,029	975	1,156	982	757	529
[13]	Forgery and Fraud	3,712	3,496	3,280	3,063	2,122	2,535	2,497	1,975	1,890	1,757	1,301	1,065
[14]	Gambling Offenses	0	0	0	0	0	0	0	0	0	0	0	0
[15]	Human Trafficking	0	0	0	0	0	0	0	0	0	0	0	0
[16]	Larceny-theft	5,838	5,646	5,454	5,262	5,525	5,238	4,689	5,630	5,454	5,319	5,551	4,586
[17]	Liquor Laws	0	0	0	0	0	0	0	0	1	1	2	23
[18]	Motor Vehicle Theft	27	29	30	32	39	58	47	37	63	75	63	77
[19]	Murder	344	385	426	467	474	482	622	529	633	817	830	706
[20]	Other Assaults	282	272	263	253	40	68	60	94	112	92	81	80
[21]	Prostitution	45	46	48	50	63	51	131	111	148	95	71	44
[22]	Robbery	2,725	2,738	2,752	2,766	2,568	2,372	2,362	2,510	2,581	2,819	3,747	3,195
[23]	Sex Offenses	5,371	5,052	4,732	4,412	3,460	3,117	2,378	2,771	2,964	3,050	1,835	981
[24]	Stolen Property	0	0	0	0	0	0	0	0	0	0	0	0
[25]	Vandalism	1,073	1,062	1,050	1,039	1,259	1,524	1,252	1,359	1,553	1,735	1,959	1,513
[26]	Weapons	1,344	1,585	1,825	2,066	2,651	2,369	2,483	2,350	3,019	3,302	4,043	4,776
[27]	Subtotal	61,150	59,349	57,549	55,748	56,874	54,075	50,943	50,295	53,116	53,193	53,991	50,415
[28]	Other Charges	238	240	242	243	272	273	276	378	771	692	597	540
[29]	Total Charges	61,388	59,589	57,790	55,992	57,146	54,348	51,219	50,673	53,887	53,885	54,588	50,955

Sources & Notes:

[1]-[26]: Charges where offenses are identifiable by FBI UCR offense classification. 2010-2017 based on analysis of prosecution data for adult and juvenile offenders obtained from Cuyahoga County Prosecutor's Office (CUYAH_000097414). Because prosecution data is not available for 2006-2008 and prosecution data on juvenile charges is incomplete in 2009, total charges are estimated based upon the relationship of adult charges to total charges in 2010 (i.e., 2006-2009 estimated based on relationship between Panel C1[1:26] and Panel D1[1:26] in 2010).

[27]=Σ[1:26].

[28]: Charges where offenses are not identifiable by FBI UCR offense classification. 2010-2017 based on analysis of prosecution data for adult and juvenile offenders obtained from Cuyahoga County Prosecutor's Office (CUYAH_000097414). Because prosecution data is not available for 2006-2008 and prosecution data on juvenile charges is incomplete in 2009, total charges are estimated based upon the relationship of adult charges to total charges in 2010 (i.e., 2006-2009 estimated based on relationship between Panel C1[28] and Panel D1[28] in 2010).

[29]=Σ[27:28].

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APPENDIX III.C.1
Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C2 - DRUG-RELATED CHARGES BY OFFENSE TYPES													
[1]	Aggravated Assault	150	148	145	143	157	146	144	126	139	153	151	139
[2]	All Other Offenses	1,215	1,180	1,146	1,111	1,206	1,112	1,079	1,040	1,194	1,272	1,270	1,119
[3]	Arson	4	4	4	3	4	5	2	3	2	2	3	4
[4]	Burglary	1,007	972	937	903	1,058	1,014	964	936	926	952	1,041	818
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	0	1	3	4	4	4	3	5	6	10	10	15
[8]	Drug Crimes	14,581	13,951	13,321	12,691	13,022	12,027	11,347	10,828	9,853	7,890	8,200	10,274
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	85	80	75	70	61	75	57	54	64	54	42	29
[13]	Forgery and Fraud	1,195	1,125	1,056	986	683	816	804	636	608	566	419	343
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	1,679	1,624	1,568	1,513	1,589	1,506	1,348	1,619	1,568	1,530	1,596	1,319
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	7	7	7	8	9	14	11	9	15	18	15	19
[19]	Murder	13	15	17	18	19	19	24	21	25	32	32	28
[20]	Other Assaults	12	12	11	11	2	3	3	4	5	4	4	3
[21]	Prostitution	23	24	25	25	32	26	67	57	76	49	36	22
[22]	Robbery	803	807	811	815	757	699	696	739	760	831	1,104	941
[23]	Sex Offenses	51	48	45	42	33	29	22	26	28	29	17	9
[24]	Stolen Property	0	0	0	0	0	0	0	0	0	0	0	0
[25]	Vandalism	30	30	29	29	35	43	35	38	44	49	55	42
[26]	Weapons	40	47	54	61	78	70	73	70	89	98	120	141
[27]	Total Charges Related to Drugs	20,894	20,074	19,254	18,434	18,748	17,608	16,681	16,210	15,403	13,537	14,116	15,266

Sources & Notes:
[1:26]=Panel C1[1:26]*Appendix III.C.3, Panel A[1:26].
[27]=Σ[1:26].

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APPENDIX III.C.1
Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C3 - OPIOID-RELATED CHARGES BY OFFENSE TYPES													
[1]	Aggravated Assault	37	36	47	46	52	49	53	46	51	56	55	51
[2]	All Other Offenses	298	289	368	357	401	370	395	380	437	465	465	410
[3]	Arson	1	1	1	1	1	2	1	1	1	1	1	1
[4]	Burglary	247	238	301	290	352	337	353	342	339	348	381	299
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	0	0	1	1	1	1	1	2	2	4	4	5
[8]	Drug Crimes	1,852	1,772	2,238	2,854	3,576	3,408	3,093	3,128	3,022	2,641	2,778	3,758
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	21	20	24	23	20	25	21	20	23	20	15	11
[13]	Forgery and Fraud	293	276	339	317	227	272	294	233	223	207	153	125
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	412	398	504	486	529	501	493	592	574	560	584	482
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	2	2	2	2	3	5	4	3	6	7	6	7
[19]	Murder	3	4	5	6	6	6	9	8	9	12	12	10
[20]	Other Assaults	3	3	4	4	1	1	1	1	2	1	1	1
[21]	Prostitution	6	6	8	8	11	9	25	21	28	18	13	8
[22]	Robbery	197	198	261	262	252	233	255	271	278	304	404	344
[23]	Sex Offenses	12	12	14	13	11	10	8	10	10	11	6	3
[24]	Stolen Property	0	0	0	0	0	0	0	0	0	0	0	0
[25]	Vandalism	7	7	9	9	12	14	13	14	16	18	20	16
[26]	Weapons	10	12	17	20	26	23	27	25	33	36	44	52
[27]	Total Charges Related to Opioids	3,400	3,273	4,146	4,700	5,482	5,265	5,044	5,097	5,052	4,707	4,942	5,584

Sources & Notes:
[1:26]=Panel C2[1:26]*Appendix III.C.3, Panel B[1:26].
[27]=Σ[1:26].

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APPENDIX III.C.1

Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D1 - ADULT CHARGES BY OFFENSE TYPES													
[1]	Aggravated Assault	3,193	3,143	3,094	3,044	3,340	3,113	2,990	2,537	2,661	3,025	2,960	2,712
[2]	All Other Offenses	16,269	15,805	15,342	14,879	16,147	14,277	13,372	11,825	11,897	12,742	12,797	11,580
[3]	Arson	269	260	251	242	273	319	157	127	122	157	193	256
[4]	Burglary	2,719	2,626	2,532	2,439	2,857	2,677	2,453	2,270	1,969	1,916	2,400	1,883
[5]	Curfew/Loitering/Vagrancy	0	0	0	0	0	0	0	0	0	0	0	0
[6]	Disorderly Conduct	4	4	4	4	3	2	2	1	3	3	3	4
[7]	Driving Under the Influence	2	37	73	108	112	111	95	134	163	281	276	414
[8]	Drug Crimes	14,420	13,797	13,174	12,551	12,878	11,892	11,225	10,555	9,346	7,452	7,713	9,772
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	1,345	1,265	1,185	1,105	960	1,147	773	734	871	705	491	453
[13]	Forgery and Fraud	3,703	3,488	3,272	3,056	2,117	2,534	2,496	1,950	1,877	1,727	1,268	1,014
[14]	Gambling Offenses	0	0	0	0	0	0	0	0	0	0	0	0
[15]	Human Trafficking	0	0	0	0	0	0	0	0	0	0	0	0
[16]	Larceny-theft	5,378	5,202	5,025	4,848	5,090	4,867	4,123	4,715	4,158	3,937	4,062	3,423
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	1	2	22
[18]	Motor Vehicle Theft	27	29	30	32	39	52	45	28	41	39	40	63
[19]	Murder	327	366	405	444	451	471	595	477	583	774	765	645
[20]	Other Assaults	282	272	263	253	40	63	55	86	105	90	67	61
[21]	Prostitution	44	46	47	49	62	50	131	109	146	90	71	44
[22]	Robbery	2,439	2,452	2,464	2,476	2,299	2,072	1,936	1,921	1,888	2,099	2,707	2,352
[23]	Sex Offenses	4,945	4,650	4,356	4,061	3,185	2,978	2,218	2,600	2,665	2,781	1,601	818
[24]	Stolen Property	0	0	0	0	0	0	0	0	0	0	0	0
[25]	Vandalism	995	985	974	964	1,168	1,353	1,018	995	926	929	1,380	884
[26]	Weapons	1,278	1,506	1,735	1,963	2,519	2,201	2,293	2,114	2,701	2,902	3,440	4,247
[27]	Subtotal	57,638	55,932	54,225	52,518	53,540	50,179	45,977	43,178	42,122	41,650	42,236	40,647
[28]	Other Offenses	158	160	161	162	181	156	189	157	193	203	154	176
[29]	Total Adult Charges	57,797	56,091	54,386	52,680	53,721	50,335	46,166	43,335	42,315	41,853	42,390	40,823

Sources & Notes:

[1]-[26]: Charges where offenses are identifiable by FBI UCR offense classification - excludes juvenile offenders. 2009-2017 based on analysis of prosecution data for adult offenders obtained from Cuyahoga County Prosecutor's Office (CUYAH_000097414). 2006-2008 estimated based on trend of the data in 2009-2017.

[27]=Σ[1:26].

[28]: Charges where offenses are not identifiable by FBI UCR offense classification - excludes juvenile offenders. 2009-2017 based on analysis of prosecution data for adult offenders obtained from Cuyahoga County Prosecutor's Office (CUYAH_000097414). 2006-2008 estimated based on trend of the data in 2009-2017.

[29]=Σ[27:28].

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APPENDIX III.C.1

Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D2 - DRUG-RELATED ADULT CHARGES BY OFFENSE TYPES													
[1]	Aggravated Assault	141	139	137	134	147	137	132	112	117	133	131	120
[2]	All Other Offenses	1,137	1,104	1,072	1,040	1,128	998	934	826	831	890	894	809
[3]	Arson	4	3	3	3	4	4	2	2	2	2	3	3
[4]	Burglary	878	848	818	788	923	864	792	733	636	619	775	608
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	0	1	3	4	4	4	3	5	6	10	10	15
[8]	Drug Crimes	14,420	13,797	13,174	12,551	12,878	11,892	11,225	10,555	9,346	7,452	7,713	9,772
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	75	70	66	61	53	64	43	41	48	39	27	25
[13]	Forgery and Fraud	1,192	1,123	1,053	984	682	816	804	628	604	556	408	326
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	1,547	1,496	1,445	1,394	1,464	1,400	1,186	1,356	1,196	1,132	1,168	984
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	7	7	7	8	9	13	11	7	10	9	10	15
[19]	Murder	13	14	16	17	18	18	23	19	23	30	30	25
[20]	Other Assaults	12	12	11	11	2	3	2	4	5	4	3	3
[21]	Prostitution	22	23	24	25	32	26	67	56	75	46	36	22
[22]	Robbery	719	722	726	729	677	610	570	566	556	618	798	693
[23]	Sex Offenses	47	44	41	38	30	28	21	25	25	26	15	8
[24]	Stolen Property	0	0	0	0	0	0	0	0	0	0	0	0
[25]	Vandalism	28	28	27	27	33	38	29	28	26	26	39	25
[26]	Weapons	38	45	51	58	75	65	68	63	80	86	102	126
[27]	Total Adult Charges Related to Drugs	20,277	19,476	18,674	17,873	18,157	16,979	15,912	15,023	13,585	11,680	12,161	13,579

Sources & Notes:

[1:26]=Panel D1[1:26]*Appendix III.C.3, Panel A[1:26].

[27]=Σ[1:26].

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APPENDIX III.C.1
Opioid-Related Percent of Criminal Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D3 - OPIOID-RELATED ADULT CHARGES BY OFFENSE TYPES													
[1]	Aggravated Assault	35	34	44	43	49	46	48	41	43	49	48	44
[2]	All Other Offenses	279	271	345	334	375	332	342	302	304	326	327	296
[3]	Arson	1	1	1	1	1	1	1	1	1	1	1	1
[4]	Burglary	215	208	263	253	307	288	290	268	233	226	284	222
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	0	0	1	1	1	1	1	2	2	4	4	5
[8]	Drug Crimes	1,831	1,752	2,213	2,822	3,537	3,370	3,060	3,049	2,866	2,494	2,613	3,574
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	18	17	21	20	18	21	16	15	18	14	10	9
[13]	Forgery and Fraud	292	275	339	316	227	271	294	230	221	203	149	119
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	379	367	465	448	487	466	434	496	437	414	427	360
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	2	2	2	2	3	4	4	2	4	3	4	6
[19]	Murder	3	4	5	6	6	6	9	7	8	11	11	9
[20]	Other Assaults	3	3	4	4	1	1	1	1	2	1	1	1
[21]	Prostitution	6	6	8	8	11	9	25	20	27	17	13	8
[22]	Robbery	176	177	233	235	225	203	209	207	203	226	292	254
[23]	Sex Offenses	11	11	13	12	10	9	8	9	9	10	6	3
[24]	Stolen Property	0	0	0	0	0	0	0	0	0	0	0	0
[25]	Vandalism	7	7	9	9	11	13	10	10	9	10	14	9
[26]	Weapons	9	11	16	19	25	22	25	23	29	31	37	46
[27]	Total Adult Charges Related to Opioids	3,268	3,145	3,982	4,533	5,294	5,063	4,774	4,684	4,417	4,041	4,240	4,967

Sources & Notes:
[1:26]=Panel D2[1:26]*Appendix III.C.3, Panel B[1:26].
[27]=Σ[1:26].

APPENDIX III.C.2
Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF CRIMES (Prosecutor / Court of Common Pleas / Sheriff / Adult Probation)													
[1]	Total Offenses Related to Drugs	1,160	544	743	847	756	895	851	715	842	942	962	911
[2]	Total Offenses Reported	4,093	2,128	2,990	2,904	2,964	3,086	2,881	2,572	2,843	2,877	2,860	2,820
[3]	**Drug-Related % of Crimes**	**28.3%**	**25.6%**	**24.9%**	**29.2%**	**25.5%**	**29.0%**	**29.5%**	**27.8%**	**29.6%**	**32.8%**	**33.6%**	**32.3%**
[4]	Total Offenses Related to Opioids	221	107	196	233	235	278	273	238	284	330	338	333
[5]	Total Offenses Related to Drugs	1,160	544	743	847	756	895	851	715	842	942	962	911
[6]	**Opioid % of Drug-Related Crimes**	**19.1%**	**19.7%**	**26.4%**	**27.5%**	**31.0%**	**31.0%**	**32.0%**	**33.2%**	**33.7%**	**35.0%**	**35.2%**	**36.6%**

Sources & Notes:
[1]=Panel C2[27].
[2]=Panel C1[27].
[3]=[1]/[2].
[4]=Panel C3[27].
[5]=[1].
[6]=[4]/[5].

PANEL B - OPIOID-RELATED % OF PRISONERS (Sheriff Jail / Alternative Corrections)													
[1]	Total Drug-Related State Prisoners	421,455	427,549	411,156	401,623	390,780	376,290	360,701	362,121	355,094	342,926		
[2]	Total State Prisoners	1,311,540	1,335,642	1,341,699	1,341,454	1,336,979	1,317,105	1,290,580	1,299,900	1,288,600	1,272,900		
[3]	**Drug-Related % of Prisoners**	**32.1%**	**32.0%**	**30.6%**	**29.9%**	**29.2%**	**28.6%**	**27.9%**	**27.9%**	**27.6%**	**26.9%**	**26.9%**	**26.9%**
[4]	Total Opioid-Related State Prisoners	71,929	72,501	92,586	105,160	116,259	114,091	112,354	116,476	117,703	119,316		
[5]	Total Drug-Related State Prisoners	421,455	427,549	411,156	401,623	390,780	376,290	360,701	362,121	355,094	342,926		
[6]	**Opioid % of Drug-Related Prisoners**	**17.1%**	**17.0%**	**22.5%**	**26.2%**	**29.8%**	**30.3%**	**31.1%**	**32.2%**	**33.1%**	**34.8%**	**34.8%**	**34.8%**

Sources & Notes:
[1]=Panel D2[27].
[2]=Panel D1[27].
[3]=[1]/[2]. 2016-2017 set equal to 2015.
[4]=Panel D3[27].
[5]=[1].
[6]=[4]/[5]. 2016-2017 set equal to 2015.

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APPENDIX III.C.2

Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C1 - CRIMES BY OFFENSE TYPES													
[1]	Aggravated Assault	12	8	11	9	19	18	10	9	20	16	21	24
[2]	All Other Offenses	13	7	14	15	11	13	7	19	15	11	22	16
[3]	Arson	4	4	9	5	4	10	3	4	2	4	7	7
[4]	Burglary	323	173	252	226	275	310	247	202	224	206	217	195
[5]	Curfew/Loitering/Vagrancy	0	0	0	0	0	0	0	0	0	0	0	0
[6]	Disorderly Conduct	0	0	0	0	0	0	0	0	0	0	0	0
[7]	Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
[8]	Drug Crimes	535	222	278	404	290	412	414	312	407	483	500	439
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	17	17	10	14	24	10	11	12	19	6	21	21
[13]	Forgery and Fraud	196	75	152	147	138	151	113	136	167	234	190	208
[14]	Gambling Offenses	0	0	0	3	0	1	0	0	0	1	0	0
[15]	Human Trafficking	0	0	0	0	0	0	0	0	0	0	0	0
[16]	Larceny-theft	1,276	650	921	908	924	932	919	819	881	921	940	966
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	75	62	65	49	58	61	50	48	32	48	54	69
[19]	Murder	1	0	3	1	1	1	0	1	0	2	1	2
[20]	Other Assaults	722	419	601	514	565	567	519	509	543	501	478	442
[21]	Prostitution	1	1	0	3	0	1	0	5	1	0	11	15
[22]	Robbery	23	15	14	15	16	19	8	14	15	12	13	11
[23]	Sex Offenses	15	17	18	15	25	22	17	14	25	23	19	20
[24]	Stolen Property	69	21	39	34	33	28	24	27	22	21	29	33
[25]	Vandalism	774	424	587	518	561	500	521	414	440	365	304	316
[26]	Weapons	37	13	16	24	20	30	18	27	30	23	33	36
[27]	Total Offenses Reported	4,093	2,128	2,990	2,904	2,964	3,086	2,881	2,572	2,843	2,877	2,860	2,820

Sources & Notes:

[1]-[26]: Actual offenses reported by Summit to the FBI UCR Program - National Incident-Based Reporting System.

[27]=Σ[1:26].

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APPENDIX III.C.2
Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C2 - DRUG-RELATED CRIMES BY OFFENSE TYPES													
[1]	Aggravated Assault	1	0	0	0	1	1	0	0	1	1	1	1
[2]	All Other Offenses	1	0	1	1	1	1	0	1	1	1	2	1
[3]	Arson	0	0	0	0	0	0	0	0	0	0	0	0
[4]	Burglary	104	56	81	73	89	100	80	65	72	67	70	63
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
[8]	Drug Crimes	535	222	278	404	290	412	414	312	407	483	500	439
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	1	1	1	1	1	1	1	1	1	0	1	1
[13]	Forgery and Fraud	63	24	49	47	44	49	36	44	54	75	61	67
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	367	187	265	261	266	268	264	236	253	265	270	278
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	18	15	16	12	14	15	12	12	8	12	13	17
[19]	Murder	0	0	0	0	0	0	0	0	0	0	0	0
[20]	Other Assaults	31	18	26	22	25	25	23	22	24	22	21	19
[21]	Prostitution	1	1	0	2	0	1	0	3	1	0	6	8
[22]	Robbery	7	4	4	4	5	6	2	4	4	4	4	3
[23]	Sex Offenses	0	0	0	0	0	0	0	0	0	0	0	0
[24]	Stolen Property	8	3	5	4	4	3	3	3	3	3	4	4
[25]	Vandalism	22	12	16	15	16	14	15	12	12	10	9	9
[26]	Weapons	1	0	0	1	1	1	1	1	1	1	1	1
[27]	Total Offenses Related to Drugs	1,160	544	743	847	756	895	851	715	842	942	962	911

Sources & Notes:
[1:26]=Panel C1[1:26]*Appendix III.C.3, Panel A[1:26].
[27]=Σ[1:26].

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APPENDIX III.C.2

Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C3 - OPIOID-RELATED CRIMES BY OFFENSE TYPES													
[1]	Aggravated Assault	0	0	0	0	0	0	0	0	0	0	0	0
[2]	All Other Offenses	0	0	0	0	0	0	0	0	0	0	1	0
[3]	Arson	0	0	0	0	0	0	0	0	0	0	0	0
[4]	Burglary	26	14	26	23	30	33	29	24	26	24	26	23
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
[8]	Drug Crimes	68	28	47	91	80	117	113	90	125	162	169	161
[9]	Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
[10]	Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
[11]	Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
[12]	Forcible Rape	0	0	0	0	0	0	0	0	0	0	0	0
[13]	Forgery and Fraud	15	6	16	15	15	16	13	16	20	28	22	24
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	90	46	85	84	88	89	97	86	93	97	99	102
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
[18]	Motor Vehicle Theft	4	4	5	4	5	5	4	4	3	4	5	6
[19]	Murder	0	0	0	0	0	0	0	0	0	0	0	0
[20]	Other Assaults	8	4	8	7	8	8	8	8	9	8	8	7
[21]	Prostitution	0	0	0	0	0	0	0	1	0	0	2	3
[22]	Robbery	2	1	1	1	2	2	1	2	2	1	1	1
[23]	Sex Offenses	0	0	0	0	0	0	0	0	0	0	0	0
[24]	Stolen Property	2	1	2	1	1	1	1	1	1	1	1	1
[25]	Vandalism	5	3	5	5	5	5	5	4	5	4	3	3
[26]	Weapons	0	0	0	0	0	0	0	0	0	0	0	0
[27]	Total Offenses Related to Opioids	221	107	196	233	235	278	273	238	284	330	338	333

Sources & Notes:

[1:26]=Panel C2[1:26]*Appendix III.C.3, Panel B[1:26].

[27]=Σ[1:26].

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APPENDIX III.C.2

Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D1 - STATE PRISONERS BY MOST SERIOUS OFFENSE													
[1]	Aggravated Assault	136,600	136,900	137,600	142,400	146,800	138,574	140,100	132,400	134,400	135,700		
[2]	All Other Offenses	117,919	137,726	138,896	143,162	147,038	156,118	148,640	149,900	156,200	153,300		
[3]	Arson	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[4]	Burglary	138,000	126,500	129,500	129,900	130,000	128,823	130,700	139,500	132,600	126,000		
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[7]	Driving Under the Influence	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[8]	Drug Crimes	265,800	273,600	258,000	247,900	237,000	225,242	210,200	208,000	206,300	197,200		
[9]	Drunkenness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[10]	Embezzlement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[11]	Family and Children	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[12]	Forcible Rape	54,800	70,300	72,200	71,300	70,200	72,320	70,244	72,557	71,073	70,680		
[13]	Forgery and Fraud	34,400	34,400	31,600	31,300	30,800	30,333	26,300	27,300	29,700	24,700		
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[16]	Larceny-theft	51,600	53,300	44,200	45,200	45,900	42,029	49,100	50,200	47,000	47,700		
[17]	Liquor Laws	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[18]	Motor Vehicle Theft	27,100	23,100	18,200	16,600	15,000	14,703	11,800	10,700	11,100	9,400		
[19]	Murder	161,200	183,300	188,000	188,400	188,200	184,813	184,500	183,600	188,800	195,100		
[20]	Other Assaults	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[21]	Prostitution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[22]	Robbery	179,500	178,400	185,600	186,000	185,800	181,415	179,500	181,100	168,600	171,400		
[23]	Sex Offenses	105,500	82,200	90,700	90,800	90,600	93,336	90,656	93,643	91,727	91,220		
[24]	Stolen Property	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[25]	Vandalism	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[26]	Weapons	39,121	35,916	47,203	48,492	49,641	49,399	48,840	51,000	51,100	50,500		
[27]	Total State Prisoners	1,311,540	1,335,642	1,341,699	1,341,454	1,336,979	1,317,105	1,290,580	1,299,900	1,288,600	1,272,900		

Sources & Notes:

[1]-[26]: Estimated number of sentenced prisoners under state jurisdiction at year end by most serious offense. Bureau of Justice Statistics - Prisoner Statistics.

[27]=Σ[1:26].

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APPENDIX III.C.2

Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D2 - DRUG-RELATED STATE PRISONERS BY MOST SERIOUS OFFENSE													
[1]	Aggravated Assault	6,028	6,041	6,072	6,284	6,478	6,115	6,183	5,843	5,931	5,989		
[2]	All Other Offenses	8,240	9,624	9,706	10,004	10,275	10,909	10,387	10,475	10,915	10,713		
[3]	Arson	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[4]	Burglary	44,564	40,850	41,819	41,948	41,981	41,601	42,207	45,048	42,820	40,689		
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[7]	Driving Under the Influence	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[8]	Drug Crimes	265,800	273,600	258,000	247,900	237,000	225,242	210,200	208,000	206,300	197,200		
[9]	Drunkenness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[10]	Embezzlement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[11]	Family and Children	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[12]	Forcible Rape	3,038	3,897	4,002	3,953	3,892	4,009	3,894	4,022	3,940	3,918		
[13]	Forgery and Fraud	11,075	11,075	10,174	10,077	9,916	9,766	8,467	8,789	9,562	7,952		
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[16]	Larceny-theft	14,838	15,327	12,710	12,998	13,199	12,086	14,119	14,436	13,515	13,717		
[17]	Liquor Laws	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[18]	Motor Vehicle Theft	6,529	5,565	4,385	3,999	3,614	3,542	2,843	2,578	2,674	2,265		
[19]	Murder	6,306	7,170	7,354	7,370	7,362	7,230	7,217	7,182	7,386	7,632		
[20]	Other Assaults	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[21]	Prostitution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[22]	Robbery	52,883	52,558	54,680	54,798	54,739	53,447	52,883	53,354	49,671	50,496		
[23]	Sex Offenses	997	777	857	858	856	882	857	885	867	862		
[24]	Stolen Property	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[25]	Vandalism	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[26]	Weapons	1,157	1,063	1,397	1,435	1,469	1,462	1,445	1,509	1,512	1,494		
[27]	Total Drug-Related State Prisoners	421,455	427,549	411,156	401,623	390,780	376,290	360,701	362,121	355,094	342,926		

Sources & Notes:

[1:26]=Panel D1[1:26]*Appendix III.C.3, Panel A[1:26].

[27]=Σ[1:26].

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APPENDIX III.C.2

Opioid-Related Percent of Criminal Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D3 - OPIOID-RELATED STATE PRISONERS BY MOST SERIOUS OFFENSE													
[1]	Aggravated Assault	1,478	1,482	1,952	2,020	2,156	2,035	2,262	2,138	2,170	2,191		
[2]	All Other Offenses	2,021	2,360	3,120	3,216	3,419	3,630	3,800	3,832	3,993	3,919		
[3]	Arson	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[4]	Burglary	10,929	10,019	13,444	13,486	13,968	13,842	15,441	16,481	15,666	14,886		
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[7]	Driving Under the Influence	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[8]	Drug Crimes	33,755	34,745	43,349	55,741	65,092	63,832	57,293	60,091	63,268	66,003		
[9]	Drunkenness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[10]	Embezzlement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[11]	Family and Children	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[12]	Forcible Rape	745	956	1,287	1,271	1,295	1,334	1,425	1,472	1,441	1,433		
[13]	Forgery and Fraud	2,716	2,716	3,271	3,240	3,299	3,249	3,098	3,215	3,498	2,909		
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[16]	Larceny-theft	3,639	3,759	4,086	4,179	4,392	4,021	5,165	5,281	4,945	5,018		
[17]	Liquor Laws	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[18]	Motor Vehicle Theft	1,601	1,365	1,410	1,286	1,202	1,179	1,040	943	978	829		
[19]	Murder	1,547	1,759	2,364	2,369	2,450	2,406	2,640	2,628	2,702	2,792		
[20]	Other Assaults	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[21]	Prostitution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[22]	Robbery	12,970	12,890	17,578	17,616	18,213	17,783	19,347	19,519	18,172	18,474		
[23]	Sex Offenses	245	191	276	276	285	293	313	324	317	315		
[24]	Stolen Property	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[25]	Vandalism	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
[26]	Weapons	284	261	449	461	489	486	529	552	553	547		
[27]	Total Opioid-Related State Prisoners	71,929	72,501	92,586	105,160	116,259	114,091	112,354	116,476	117,703	119,316		

Sources & Notes:

[1:26]=Panel D2[1:26]*Appendix III.C.3, Panel B[1:26].

[27]=Σ[1:26].

APPENDIX III.C.3
Opioid-Related Percent of Criminal Activity -- General

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - DRUG-RELATED % OF CRIMINAL OFFENSES													
[1]	Aggravated Assault	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
[2]	All Other Offenses	7.0%	7.0%	7.0%	7 0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7 0%	7.0%
[3]	Arson	1.3%	1.3%	1 3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1 3%	1.3%
[4]	Burglary	32.3%	32.3%	32 3%	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%	32 3%	32.3%
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	3.5%	3.5%	3.5%	3 5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3 5%	3.5%
[8]	Drug Crimes	100.0%	100.0%	100 0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100 0%	100 0%	100.0%
[9]	Drunkenness	8.3%	8.3%	8.3%	8 3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8 3%	8.3%
[10]	Embezzlement	8.8%	8.8%	8 8%	8.8%	8.8%	8.8%	8.8%	8.8%	8.8%	8.8%	8 8%	8.8%
[11]	Family and Children	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%
[12]	Forcible Rape	5.5%	5.5%	5.5%	5 5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5 5%	5.5%
[13]	Forgery and Fraud	32.2%	32.2%	32.2%	32 2%	32.2%	32.2%	32.2%	32.2%	32.2%	32.2%	32 2%	32.2%
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	28.8%	28.8%	28 8%	28.8%	28.8%	28.8%	28.8%	28.8%	28.8%	28.8%	28 8%	28.8%
[17]	Liquor Laws	0.0%	0.0%	0 0%	0 0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0 0%	0.0%
[18]	Motor Vehicle Theft	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%
[19]	Murder	3.9%	3.9%	3 9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3 9%	3.9%
[20]	Other Assaults	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
[21]	Prostitution	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%
[22]	Robbery	29.5%	29.5%	29 5%	29.5%	29.5%	29.5%	29.5%	29.5%	29.5%	29 5%	29 5%	29.5%
[23]	Sex Offenses	0.9%	0.9%	0.9%	0 9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0 9%	0.9%
[24]	Stolen Property	12.2%	12.2%	12 2%	12.2%	12.2%	12.2%	12.2%	12.2%	12.2%	12 2%	12 2%	12.2%
[25]	Vandalism	2.8%	2.8%	2 8%	2 8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2 8%	2.8%
[26]	Weapons	3.0%	3.0%	3 0%	3 0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3 0%	3.0%

Sources & Notes:
[1]-[26]: Estimated % of each type of offense attributable to drugs. US DOJ National Drug Intelligence Center, "The Economic Impact of Illicit Drug Use on American Society" (2011), Table 1.7 (uses data from 2002 Survey Of Inmates In Local Jails (SILJ)).

APPENDIX III.C.3
Opioid-Related Percent of Criminal Activity -- General

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL B - OPIOID % OF DRUG-RELATED CRIMES													
[1]	Aggravated Assault	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[2]	All Other Offenses	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[3]	Arson	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[4]	Burglary	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[5]	Curfew/Loitering/Vagrancy	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[6]	Disorderly Conduct	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[7]	Driving Under the Influence	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[8]	Drug Crimes	12.7%	12.7%	16 8%	22.5%	27.5%	28.3%	27.3%	28.9%	30.7%	33.5%	33 9%	36.6%
[9]	Drunkenness	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[10]	Embezzlement	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[11]	Family and Children	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[12]	Forcible Rape	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[13]	Forgery and Fraud	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[14]	Gambling Offenses	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[15]	Human Trafficking	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[16]	Larceny-theft	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[17]	Liquor Laws	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[18]	Motor Vehicle Theft	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[19]	Murder	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[20]	Other Assaults	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[21]	Prostitution	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[22]	Robbery	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[23]	Sex Offenses	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[24]	Stolen Property	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[25]	Vandalism	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[26]	Weapons	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%

Sources & Notes:
[1]-[7] & [9]-[26]: See Panel C2[3].
[8]: See Panel C1[3].

APPENDIX III.C.3
Opioid-Related Percent of Criminal Activity -- General

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C1 - OPIOIDS % OF DRUG OFFENSES													
[1]	Count of Opioids Reported		8,899	10,824	15,074	19,703	20,231	23,079	26,859	30,895	37,177	53,113	46,059
[2]	Count of Substances Tested		70,075	64,421	67,039	71,739	71,388	84,673	92,970	100,741	111,076	156,804	125,917
[3]	**Opioids % of Drug Offenses**	**12.7%**	**12.7%**	**16.8%**	**22.5%**	**27.5%**	**28.3%**	**27.3%**	**28.9%**	**30.7%**	**33.5%**	**33.9%**	**36.6%**

Sources & Notes:

[1]-[2] Counts for drugs identified by Ohio forensic laboratories reporting to the National Forensic Laboratory Information System (NFLIS). U S. Drug Enforcement Administration, Diversion Control Division. 2007-2017. Table 2: State counts for the most frequently identified drugs. Retrieved from the NFLIS Public Resource Library (https://www.nflis.deadiversion.usdoj.gov/Resources/NFLISPublicResourceLibrary.aspx). 2006 is set equal to 2007 due to lack of data.

[3]=[1]/[2].

PANEL C2 - OPIOIDS % OF ILLICIT SUBSTANCE DISORDERS													
[1]	Population % with Illicit Substance Disorders	3.3%	3.3%	2 8%	2 8%	3.1%	3.1%	3.0%	3.0%				
[2]	Population % with Opioid Use Disorder	0.8%	0.8%	0 9%	0 9%	1.0%	1.0%	1.1%	1.1%				
[3]	**Opioid % of Illicit Substance Disorders**	**24.5%**	**24.5%**	**32.1%**	**32.1%**	**33.3%**	**33.3%**	**36.6%**	**36.6%**	**36.6%**	**36.6%**	**36.6%**	**36.6%**

Sources & Notes:

2006-2013 estimated using Ohio response data from the National Survey on Drug Use and Health (NSDUH). State-level NSDUH data is reported as two year averages. 2014-2017 data set equal to 2013 due to changes in NSDUH definition of OUD.

[3]=[2]/[1].

Appendix III.D: Opioid-Related Percent of Treatment and Addiction Services

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APPENDIX III.D.1

Opioid-Related Percent of Addiction and Treatment Services -- Cuyahoga

	$ millions	2005	2006		2007		2008		2009		2010		2011		2012		2013	2014	2015	2016	2017
		2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H					
PANEL A - OPIOID-RELATED % OF SERVICES (ADAMHS Board)																					
[1]	Addiction Treatment Services							$31.79		$31.51		$29.83		$35.37			$16.80	$13.80	$17.00	$18.20	$21.50
[2]	Total Expenditures							$156.81		$157.59		$159.97		$189.38			$64.60	$58.70	$64.20	$67.20	$73.18
[3]	Addiction-Related % of Spending (Fiscal Year)							20.3%		20.0%		18.6%		18.7%			26.0%	23.5%	26.5%	27.1%	29.4%
[4]	**Addiction-Related % of Spending (Calendar Year)**		**23.9%**		**23.9%**		**23.8%**		**20.1%**		**19.3%**		**18.7%**		**18.7%**		**26.0%**	**23.5%**	**26.5%**	**27.1%**	**29.4%**
[5]	OUD Diagnosed Individuals Receiving Substance Use Services	1,640						1,961		2,031		2,047		2,303			1,409	1,304	987	840	1,535
[6]	Total Individuals Receiving Substance Use Services (Adjusted)	12,008						9,707		9,123		9,185		10,522			5,273	4,272	2,970	1,863	3,232
[7]	Opioid-Related % of Individuals Treated (Fiscal Year)	13.7%						20.2%		22.3%		22.3%		21.9%			26.7%	30.5%	33.2%	45.1%	47.5%
[8]	**Opioid-Related % of Individuals Treated (Calendar Year)**		**13.7%**		**16.2%**		**18.7%**		**21.2%**		**22.3%**		**22.1%**		**21.9%**		**26.7%**	**30.5%**	**33.2%**	**45.1%**	**47.5%**

Sources & Notes:
[1]: Panel B2[17].
[2]: Panel B2[16]+Panel B3[16].
[3]=[1]/[2].
[4]: 2006-2008 equal to Panel B1[7]. 2009-2012 are calculated by assuming an equivalent amount of expenditures occur over each six month period of each fiscal year. 2013-2017 equal to [3].
[5]=Panel C[5].
[6]=Panel C[9].
[7]=[5]/[6].
[8]: 2006 set equal to [7] in fiscal year 2H2005-1H2006. 2007-2008 are estimated using the linear trend between 2006 and 2009. 2009-2012 are calculated by assuming an equal number of individuals are treated in each six month period of each fiscal year. 2012-2017 equal to [7].

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APPENDIX III.D.1

Opioid-Related Percent of Addiction and Treatment Services -- Cuyahoga

$ millions	2005	2006		2007		2008		2009		2010		2011		2012		2013	2014	2015	2016	2017
	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H					
PANEL B1 - CONTRIBUTIONS TO ADAMHS BOARD, ADAS BOARD, AND CMH BOARD																				
[1] Alcohol & Drug Addiction (ADAS) Board		$10.08		$10.38		$10.07		$4.86												
[2] ADAMHS Board								$18.43		$36.00		$33.61		$35.11		$34.86	$39.36	$39.36	$39.36	$39.36
[3] Community Mental Health (CMH) Board		$27.68		$28.51		$27.85		$13.07												
[4] Total Contributions		$37.76		$38.89		$37.92		$36.36		$36.00		$33.61		$35.11		$34.86	$39.36	$39.36	$39.36	$39.36
[5] ADAS Board % of Total Contributions		26.7%		26.7%		26.6%														
[6] Administrative Expense Adjustment		89.6%		89.6%		89.6%														
[7] Addiction-Related % of Spending (Fiscal Year)		23.9%		23.9%		23.8%														

Sources & Notes:

[1]-[3]: Cuyahoga expenditure data (CUYAH_014627783).

[4]=Σ[1:3].

[5]=[1]/[4].

[6]=(1-Panel B2[18] for fiscal year 2H2008-1H2009).

[7]=[5]*[6].

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APPENDIX III.D.1

Opioid-Related Percent of Addiction and Treatment Services -- Cuyahoga

	$ millions	2005	2006		2007		2008		2009		2010		2011		2012		2013	2014	2015	2016	2017
		2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H					
PANEL B2 - ADDICTION SERVICES EXPENSES																					
[1]	Assessment						$2.08	$1.24	$1.33	$1.73							$0.80	$0.40	$0.60	$0.00	$0.41
[2]	Board Administration						$3.69	$0.00	$2.54	$1.70							$1.50	$1.30	$1.50	$1.60	$1.78
[3]	Board Grants/Reserves						$3.04	$7.10	$5.36	$0.00							$0.00	$0.00	$0.00	$0.00	$0.00
[4]	Case Management/Counseling						$7.49	$6.20	$7.25	$9.86							$2.80	$1.60	$2.10	$0.00	$3.13
[5]	Crisis Intervention						$0.02	$0.52	$0.03	$0.00							$0.00	$0.00	$0.00	$0.00	$0.00
[6]	Detoxification						$2.12	$2.10	$2.09	$2.57							$2.20	$2.00	$1.70	$2.00	$2.19
[7]	Employment/Vocational						$0.00	$0.00	$0.00	$2.88							$0.40	$0.50	$0.60	$0.60	$0.33
[8]	Housing						$0.00	$0.00	$0.00	$0.00							$0.00	$1.00	$0.60	$1.10	$1.76
[9]	Intensive Outpatient						$4.53	$4.27	$4.42	$6.50							$2.50	$1.60	$0.90	$5.20	$0.73
[10]	Laboratory Urinalysis						$1.62	$1.62	$1.73	$2.48							$0.00	$0.00	$0.00	$0.00	$0.00
[11]	Medical Treatment						$0.33	$0.30	$0.16	$0.35							$0.30	$0.40	$0.80	$0.00	$1.26
[12]	Methadone Administration						$0.86	$1.10	$1.12	$1.54							$0.00	$0.00	$0.00	$0.00	$0.00
[13]	Other Alcohol & Drug Services						$0.00	$0.46	$0.07	$0.35							$0.00	$0.10	$0.50	$0.20	$0.18
[14]	Prevention						$4.48	$3.31	$2.89	$2.50							$2.70	$2.80	$2.80	$2.00	$2.98
[15]	Residential						$5.21	$3.27	$3.40	$4.61							$5.10	$3.40	$6.40	$7.10	$8.53
[16]	Total Addiction Services Expenditures						$35.48	$31.51	$32.37	$37.08							$18.30	$15.10	$18.50	$19.80	$23.28
[17]	Addiction Treatment Services						$31.79	$31.51	$29.83	$35.37							$16.80	$13.80	$17.00	$18.20	$21.50
[18]	*Administrative Expenses % of Total*						*10.4%*	*0.0%*	*7.8%*	*4.6%*							*8.2%*	*8.6%*	*8.1%*	*8.1%*	*7.6%*

Sources & Notes:

[1]-[15]: 2009-2017 ADAMHS Annual Reports, p. 8.

[2]: Fiscal Year 2010 lacks a Board Administration figure.

[16]=Σ[1:15].

[17]=[16]-[2].

[18]=[2]/[16].

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APPENDIX III.D.1

Opioid-Related Percent of Addiction and Treatment Services -- Cuyahoga

$ millions	2005	2006		2007		2008		2009		2010		2011		2012		2013	2014	2015	2016	2017
	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H					
PANEL B3 - MENTAL HEALTH SERVICES EXPENSES																				
[1] Assessment			$4.83		$4.62		$4.76		$5.31		$6.04		$6.66			$0.40	$0.30	$0.30	$0.00	$0.00
[2] Board Administration			$5.31		$5.36		$6.11		$7.00		$3.66		$6.99			$3.60	$3.80	$3.80	$3.60	$3.81
[3] Board Grants/Reserves			$1.36		$8.88		$3.92		$5.17		$3.43		$0.00			$0.00	$0.00	$0.00	$0.00	$0.00
[4] CPST/Psychiatric Treatment			$37.19		$37.10		$37.50		$41.55		$41.36		$49.35			$8.60	$7.20	$9.50	$3.90	$3.00
[5] Counseling/Outpatient Treatment			$13.99		$15.17		$16.78		$19.75		$25.23		$31.41			$4.80	$5.60	$3.40	$8.90	$8.30
[6] Crisis Intervention			$2.54		$2.14		$2.80		$1.24		$2.29		$1.30			$5.10	$5.90	$8.00	$7.60	$7.61
[7] Employment/Vocational			$1.93		$1.51		$1.91		$1.67		$1.24		$2.61			$4.90	$3.40	$3.90	$2.30	$2.38
[8] Housing			$0.00		$0.00		$0.00		$0.00		$0.00		$0.00			$0.00	$3.70	$0.00	$0.00	$0.00
[9] Other Mental Health Services			$10.37		$4.54		$8.82		$3.64		$4.67		$3.17			$0.00	$0.00	$0.00	$1.80	$1.80
[10] Partial Hospitalization			$15.08		$15.37		$14.78		$13.93		$15.29		$17.53			$1.50	$0.40	$0.50	$0.00	$0.00
[11] Pharmacological Management			$14.71		$14.99		$15.15		$16.52		$15.67		$18.18			$2.50	$1.80	$1.80	$0.00	$0.00
[12] Prevention			$0.00		$0.00		$0.00		$0.00		$0.00		$0.00			$1.00	$1.00	$1.60	$2.00	$2.55
[13] Psychiatric Diagnosis/Evaluation			$0.65		$0.73		$0.83		$0.81		$0.92		$1.26			$0.40	$0.80	$1.60	$1.40	$1.15
[14] Recovery Support			$0.00		$0.00		$0.00		$0.00		$0.00		$1.95			$2.50	$1.80	$1.40	$2.70	$3.16
[15] Residential			$12.95		$13.20		$7.97		$9.49		$7.81		$11.88			$11.00	$7.90	$9.90	$13.20	$16.14
[16] Total Mental Health Services Expenses			$120.91		$123.61		$121.33		$126.08		$127.60		$152.30			$46.30	$43.60	$45.70	$47.40	$49.90

Sources & Notes:

[1]-[15]: 2007-2008 CMH Annual Reports, pp. 9-10; 2009 ADAMHS Annual Report, p. 6; and 2010-2017 ADAMHS Annual Reports, p. 8.

[16]=Σ[1:15].

APPENDIX III.D.1

Opioid-Related Percent of Addiction and Treatment Services -- Cuyahoga

$ millions	2005	2006		2007		2008		2009		2010		2011		2012		2013	2014	2015	2016	2017
	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H					
PANEL C - INDIVIDUALS RECEIVING SUBSTANCE USE SERVICES BY PRIMARY DRUG / DIAGNOSIS																				
[1] Alcohol	3,211					2,255		2,021		1,951		2,248				1,145	896	649	469	792
[2] Alcohol and Drugs	N/A					N/A		N/A		N/A		N/A				N/A	N/A	446	N/A	N/A
[3] Cannabis	3,717					2,665		2,587		2,679		2,767				1,091	826	488	230	380
[4] Cocaine/Crack	3,123					1,378		1,126		1,030		1,051				486	372	243	201	355
[5] Opioids (Incl. Heroin)	1,640					1,961		2,031		2,047		2,303				1,409	1,304	987	840	1,535
[6] Other Drugs / Diagnosis	317					1,448		1,358		1,478		2,153				1,142	874	157	123	170
[7] Unknown/Missing	279					N/A		N/A		N/A		N/A				N/A	N/A	585	940	N/A
[8] Individuals Receiving Substance Use Services	12,287					9,707		9,123		9,185		10,522				5,273	4,272	3,555	2,803	3,232
[9] Individuals Receiving Substance Use Services (Adjusted)	12,008					9,707		9,123		9,185		10,522				5,273	4,272	2,970	1,863	3,232

Sources & Notes:

[1]-[7]: Alcohol & Drug Addiction Services Board MACSIS Records FY2006 at p. 11; 2009 ADAMHS Annual Report at p. 20; 2010-2017 ADAMHS Annual Reports at p. 11.

[8]=Σ[1:7].

[9]=[8]-[7].

APPENDIX III.D.2
Opioid-Related Percent of Addiction and Treatment Services -- Summit

	$ millions	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF SPENDING (ADM Board)													
[1]	Board Administration	$2.37	$2 35	$2.41	$2.96	$2.50	$2.44	$2.30	$2.38	$2.49	$2.44	$2.60	$2.59
[2]	Mental Health Services	$35.26	$34.49	$35.53	$40.58	$21.46	$22.95	$23 29	$24.18	$23.13	$21.87	$23.35	$25.15
[3]	Alcohol & Drug Treatment	$15.50	$15 23	$14.02	$15.66	$12.52	$12.83	$13.12	$13.30	$13.62	$13.31	$13.73	$14.79
[4]	Other Services	$9.01	$11 00	$11.82	$17.33	$36.99	$38.30	$19 89	$2.76	$1.44	$1.99	$2.88	$3.10
[5]	Total Expenditures	$62.14	$63 07	$63.78	$76.52	$73.47	$76.53	$58.60	$42.61	$40.69	$39.60	$42 56	$45.63
[6]	**Addiction-Related % of Spending**	**24.9%**	**24.2%**	**22.0%**	**20.5%**	**17.0%**	**16.8%**	**22.4%**	**31.2%**	**33.5%**	**33.6%**	**32.3%**	**32.4%**
[7]	Total OUD Expenditures	$1.06	$1 22	$1.43	$2.17	$4.32	$4.27	$4.79	$5.14	$5.15	$5.22	$6 53	$6.27
[8]	Addiction-Related Spending	$15.50	$15 23	$14.02	$15.66	$12.52	$12.83	$13.12	$13.30	$13.62	$13.31	$13.73	$14.79
[9]	**Opioid-Related % of Addiction Spending**	**6.8%**	**8.0%**	**10.2%**	**13.9%**	**34.5%**	**33.3%**	**36.5%**	**38.7%**	**37.8%**	**39.2%**	**47.5%**	**42.4%**

Sources & Notes:

[1]-[5]: As reported in financial statements in ADM Board Annual Budget Reviews: 2006 per 2009 Budget Review at p. 94 (SUMMIT_000019258-387 at 355); 2007-2009 per 2010 Budget Review at p. 77 (SUMMIT_000019388-489 at 466) (2009 is budget expenditure not actual); 2010-2011 per 2013 Budget Review at p. 64 (SUMMIT_001184459-547 at 526); 2012-2013 per 2015 Budget Review at p. 69 (SUMMIT_000019490-579 at 562); 2014 per 2016 Budget Review at p. 71 (SUMMIT_000019580-667 at 654); 2015-2016 per 2018 Budget Review at p. 54 (SUMMIT_001085282-386 at 365); 2017 per ADM Board 2017 Report to the Community at PDF p. 7, which only reports [1] and [5]; therefore, [2]-[4] estimated based on relative distribution of [2]-[4] in 2016 expenditure data.

[5]=Σ[1:4].
[6]=[3]/[5].
[7]=Panel B[10].
[8]=[3].
[9]=[7]/[8].

	PANEL B - OUD EXPENDITURES BY TREATMENT / SERVICE												
[1]	Assessment / Case Management	$0.06	$0 06	$0.04	$0.19	$0.28	$0.21	$0.20	$0.27	$0.18	$0.14	$0.15	$0.07
[2]	Counseling / Therapy	$0.16	$0.13	$0.17	$0.30	$0.25	$0.19	$0.28	$0.26	$0.12	$0.09	$0.14	$0.13
[3]	Detoxification	$0.00	$0 00	$0.02	$0.83	$0.58	$0.60	$0.59	$1.03	$0.75	$0.83	$1 29	$1.35
[4]	Drug Testing	$0.02	$0 05	$0.14	$0.06	$0.05	$0.14	$0.20	$0.21	$0.11	$0.05	$0.13	$0.11
[5]	Intensive Outpatient	$0.11	$0.11	$0.13	$0.16	$0.20	$0.15	$0.16	$0.38	$0 26	$0.10	$0.10	$0.09
[6]	Medical Services	$0.21	$0 24	$0.11	$0.02	$0.09	$0.06	$0.10	$0.15	$0 05	$0.02	$0 02	$0.02
[7]	Methadone Administration	$0.42	$0 58	$0.81	$0.60	$0.87	$0.51	$0.70	$0.28	$0.16	$0.23	$0 25	$0.15
[8]	Other Treatment / Service	$0.00	$0 00	$0.00	$0.02	$0.02	$0.03	$0.08	$0.22	$0.19	$0.32	$0.68	$0.68
[9]	Residential Treatment	$0.07	$0 04	$0.00	$0.00	$1.98	$2.39	$2.49	$2.34	$3 33	$3.43	$3.77	$3.66
[10]	Total OUD Expenditures	$1.06	$1 22	$1.43	$2.17	$4.32	$4.27	$4.79	$5.14	$5.15	$5.22	$6 53	$6.27

Sources & Notes:

[1]-[9]: Based on analysis of Summit ADM claims data for individuals with an opioid-related diagnosis (SUMMIT_001146951-952). Excludes claims outside of the substance abuse program, Medicaid claims, and Medicare claims.

[10]=Σ[1:9].

Appendix III.E: Opioid-Related Percent of Child Removals

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APPENDIX III.E.1
Opioid-Related Percent of Child Removals - Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF REMOVALS (Children and Family Services)													
[1]	**Opioid-Related % of Removals**	**4.5%**	**5.4%**	**6.2%**	**7.0%**	**7.4%**	**7.3%**	**7.2%**	**8.8%**	**10.1%**	**11.0%**	**14.9%**	**15.7%**
[2]	Opioid-Related % of Individuals Treated by Cuyahoga ADAMHS Board	13.7%	16.2%	18.7%	21.2%	22.3%	22.1%	21.9%	26.7%	30.5%	33.2%	45.1%	47.5%

Sources & Notes:

[1]: 11% of children taken into custody in 2015 had parents using opioids at the time of removal. Public Children Services Association of Ohio, "The Opioid Epidemic's Impact on Children Services in Ohio," December 2017, p. 10. 2006-2014 and 2016-2017 figures are estimated based on the trend in [2].

[2]: See Table III.5[2] and Appendix III.D.1, Panel A[8].

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APPENDIX III.E.2
Opioid-Related Percent of Child Removals - Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF REMOVALS (Children Services Board)													
[1]	**Opioid-Related % of Removals**	**4.4%**	**5.1%**	**6.5%**	**8.8%**	**22.0%**	**21.2%**	**23.3%**	**24.7%**	**24.1%**	**25.0%**	**30.3%**	**27.0%**
[2]	Opioid-Related % of Summit ADM Board Expenditures on Addiction Treatment	6.8%	8.0%	10.2%	13.9%	34.5%	33.3%	36.5%	38.7%	37.8%	39.2%	47.5%	42.4%

Sources & Notes:

[1]: 25% of children taken into custody in 2015 had parents using opioids at the time of removal. Public Children Services Association of Ohio, "The Opioid Epidemic's Impact on Children Services in Ohio," December 2017, p. 10. 2006-2014 and 2016-2017 figures are estimated based on the trend in [2].

[2]: See Table III.5[5] and Appendix III.D 2, Panel A[9].

Appendix III.F: Opioid-Related Percent of Juvenile Court Activity

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APPENDIX III.F.1
Opioid-Related Percent of Juvenile Court Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF JUVENILE CASES (Juvenile Court)													
[1]	Opioid-Related Delinquency and Unruly Charges	532	536	693	724	696	687	605	689	716	570	772	
[2]	Total Delinquency and Unruly Charges	16,638	16,679	15,459	15,395	12,821	13,175	12,301	13,326	14,966	11,614	15,479	
[3]	Opioid-Related % of Delinquency and Unruly Charges	3.2%	3.2%	4 5%	4.7%	5.4%	5.2%	4.9%	5.2%	4.8%	4 9%	5.0%	
[4]	Delinquency and Unruly Cases	11,298	11,582	11,254	10,794	8,486	8,602	8,131	7,931	7,644	5,973	7,601	
[5]	Opioid-Related Delinquency and Unruly Cases	361	372	504	508	460	449	400	410	366	293	379	
[6]	Opioid-Related % of CFS Removals	4.5%	5.4%	6 2%	7.0%	7.4%	7.3%	7.2%	8.8%	10.1%	11 0%	14 9%	
[7]	Abuse, Dependency, Neglect Cases	1,898	1,443	1,421	1,111	1,663	1,698	1,293	1,212	1,623	1,609	2,186	
[8]	Opioid-Related Abuse, Dependency, Neglect Cases	86	77	88	78	123	124	94	107	164	177	326	
[9]	Total Opioid-Related Juvenile Cases	447	449	592	586	583	573	494	517	530	470	705	
[10]	Total Official and Bypassed Cases	27,137	25,828	24,978	25,236	24,180	23,138	21,350	18,705	15,932	14,884	16,284	
[11]	**Opioid-Related % of Juvenile Cases**	**1.6%**	**1.7%**	**2.4%**	**2.3%**	**2.4%**	**2.5%**	**2.3%**	**2.8%**	**3.3%**	**3.2%**	**4.3%**	**4.3%**

Sources & Notes:
[1]=Panel C3[27].
[2]=Panel C1[27].
[3]=[1]/[2].
[4]=Panel B[1].
[5]=[3]*[4].
[6]=Appendix III.E.1, Panel A[1].
[7]=Panel B[2].
[8]=[6]*[7].
[9]=([5]+[8]).
[10]=Panel B[4].
[11]=[9]/[10]. 2017 set equal to 2016.

APPENDIX III.F.1

Opioid-Related Percent of Juvenile Court Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL B - JUVENILE CASES BY TYPE													
[1]	Delinquency and Unruly Cases	11,298	11,582	11,254	10,794	8,486	8,602	8,131	7,931	7,644	5,973	7,601	
[2]	Abuse, Dependency, Neglect Cases	1,898	1,443	1,421	1,111	1,663	1,698	1,293	1,212	1,623	1,609	2,186	
[3]	Other Cases (Traffic, Custody, etc.)	13,941	12,803	12,303	13,331	14,031	12,838	11,926	9,562	6,665	7,302	6,497	
[4]	Total Official and Bypassed Cases	27,137	25,828	24,978	25,236	24,180	23,138	21,350	18,705	15,932	14,884	16,284	

Sources & Notes:

[1]-[3]: Cuyahoga Juvenile Court Annual Reports: 2006, pp. 20-21; 2007, pp. 23-24; 2008, pp. 28-29; 2009, pp. 37-38; 2010, pp. 37-38; 2011, pp. 37-38; 2012, pp. 31-32; 2013, pp. 29-30; 2014, pp. 36-37; 2015, pp. 37-38; 2016, pp. 36-37.

[4]=Σ[1:3].

APPENDIX III.F.1

Opioid-Related Percent of Juvenile Court Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C1 - DELINQUENCY AND UNRULY CHARGES BY OFFENSE TYPE													
[1]	Aggravated Assault	734	687	790	547	537	512	477	481	665	491	608	
[2]	All Other Offenses	3,281	3,540	3,522	3,290	2,675	2,976	2,535	3,003	3,921	2,967	3,579	
[3]	Arson	156	146	67	69	66	67	46	87	80	26	60	
[4]	Burglary	579	540	593	589	521	579	565	584	374	313	355	
[5]	Curfew/Loitering/Vagrancy	2,669	2,370	1,491	2,244	1,520	1,533	1,973	1,970	1,917	1,138	1,745	
[6]	Disorderly Conduct	1,047	1,192	1,074	907	888	969	988	888	1,088	768	875	
[7]	Driving Under the Influence	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[8]	Drug Crimes	1,482	1,434	1,360	1,187	945	885	756	792	723	499	615	
[9]	Drunkenness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[10]	Embezzlement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[11]	Family and Children	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[12]	Forcible Rape	82	147	131	106	137	178	203	206	289	201	312	
[13]	Forgery and Fraud	199	166	165	197	117	212	18	35	52	55	57	
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[16]	Larceny-theft	1,795	1,891	1,821	1,908	2,003	1,799	1,538	1,787	1,879	1,419	2,091	
[17]	Liquor Laws	22	17	7	9	6	8	318	265	229	146	167	
[18]	Motor Vehicle Theft	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[19]	Murder	39	37	48	41	22	16	19	49	50	42	72	
[20]	Other Assaults	1,550	1,506	1,518	1,572	1,139	1,214	1,091	1,149	1,254	964	1,164	
[21]	Prostitution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[22]	Robbery	578	648	709	665	594	502	430	571	668	641	1,047	
[23]	Sex Offenses	177	161	239	473	323	264	150	169	208	399	418	
[24]	Stolen Property	642	651	566	458	465	567	436	438	580	576	856	
[25]	Vandalism	986	974	830	810	493	551	472	558	621	615	764	
[26]	Weapons	620	572	528	323	370	343	286	294	368	354	694	
[27]	Total Delinquency and Unruly Charges	16,638	16,679	15,459	15,395	12,821	13,175	12,301	13,326	14,966	11,614	15,479	

Sources & Notes:

[1]-[26]: Cuyahoga Juvenile Court Annual Reports: 2006, p. 31; 2007, p. 34; 2008, p. 39; 2009, p. 48; 2010, p. 48; 2011, p. 48; 2012, p. 42; 2013, p. 40; 2014, p. 47; 2015, p. 48; 2016, p. 47.
[27]=Σ[1:26].

APPENDIX III.F.1

Opioid-Related Percent of Juvenile Court Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C2 - DRUG-RELATED DELINQUENCY AND UNRULY CHARGES BY OFFENSE TYPE													
[1]	Aggravated Assault	32	30	35	24	24	23	21	21	29	22	27	
[2]	All Other Offenses	229	247	246	230	187	208	177	210	274	207	250	
[3]	Arson	2	2	1	1	1	1	1	1	1	0	1	
[4]	Burglary	187	174	191	190	168	187	182	189	121	101	115	
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[7]	Driving Under the Influence	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[8]	Drug Crimes	1,482	1,434	1,360	1,187	945	885	756	792	723	499	615	
[9]	Drunkenness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[10]	Embezzlement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[11]	Family and Children	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[12]	Forcible Rape	5	8	7	6	8	10	11	11	16	11	17	
[13]	Forgery and Fraud	64	53	53	63	38	68	6	11	17	18	18	
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[16]	Larceny-theft	516	544	524	549	576	517	442	514	540	408	601	
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	
[18]	Motor Vehicle Theft	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[19]	Murder	2	1	2	2	1	1	1	2	2	2	3	
[20]	Other Assaults	67	66	66	68	50	53	47	50	55	42	51	
[21]	Prostitution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[22]	Robbery	170	191	209	196	175	148	127	168	197	189	308	
[23]	Sex Offenses	2	2	2	4	3	2	1	2	2	4	4	
[24]	Stolen Property	78	79	69	56	57	69	53	53	71	70	104	
[25]	Vandalism	28	27	23	23	14	15	13	16	17	17	21	
[26]	Weapons	18	17	16	10	11	10	8	9	11	10	21	
[27]	Drug-Related Delinquency and Unruly Charges	2,882	2,876	2,804	2,608	2,256	2,197	1,848	2,049	2,075	1,600	2,156	

Sources & Notes:

[1:26]=Panel C1[1:26]*Appendix III.F.3, Panel A[1:26].

[27]=Σ[1:26].

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APPENDIX III.F.1

Opioid-Related Percent of Juvenile Court Activity -- Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C3 - OPIOID-RELATED DELINQUENCY AND UNRULY CHARGES BY OFFENSE TYPE													
[1]	Aggravated Assault	8	7	11	8	8	8	8	8	11	8	10	
[2]	All Other Offenses	56	61	79	74	62	69	65	77	100	76	91	
[3]	Arson	0	0	0	0	0	0	0	0	0	0	0	
[4]	Burglary	46	43	62	61	56	62	67	69	44	37	42	
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[7]	Driving Under the Influence	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[8]	Drug Crimes	188	182	229	267	260	251	206	229	222	167	208	
[9]	Drunkenness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[10]	Embezzlement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[11]	Family and Children	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[12]	Forcible Rape	1	2	2	2	3	3	4	4	6	4	6	
[13]	Forgery and Fraud	16	13	17	20	13	23	2	4	6	6	7	
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[16]	Larceny-theft	127	133	168	176	192	172	162	188	198	149	220	
[17]	Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	
[18]	Motor Vehicle Theft	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[19]	Murder	0	0	1	1	0	0	0	1	1	1	1	
[20]	Other Assaults	17	16	21	22	16	18	17	18	20	15	19	
[21]	Prostitution	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[22]	Robbery	42	47	67	63	58	49	46	62	72	69	113	
[23]	Sex Offenses	0	0	1	1	1	1	1	1	1	1	1	
[24]	Stolen Property	19	19	22	18	19	23	19	19	26	26	38	
[25]	Vandalism	7	7	7	7	5	5	5	6	6	6	8	
[26]	Weapons	4	4	5	3	4	3	3	3	4	4	8	
[27]	Opioid-Related Delinquency and Unruly Charges	532	536	693	724	696	687	605	689	716	570	772	

Sources & Notes:

[1:26]=Panel C2[1:26]*Appendix III.F.3, Panel B[1:26].

[27]=Σ[1:26].

APPENDIX III.F.2
Opioid-Related Percent of Juvenile Court Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF JUVENILE CASES (Juvenile Court)													
[1]	Opioid-Related Delinquency and Unruly Charges									176	251	239	
[2]	Total Delinquency and Unruly Charges									4,099	4,568	4,577	
[3]	Opioid-Related % of Delinquency and Unruly Charges	2.3%	2.2%	2 8%	3.5%	3.4%	3.9%	4.1%	4.0%	4.3%	5 5%	5 2%	5.2%
[4]	Delinquency and Unruly Cases	6,381	6,067	5,595	4,973	4,150	3,527	3,465	2,965	2,850	2,953	2,944	2,476
[5]	Opioid-Related Delinquency and Unruly Cases	149	132	158	172	142	137	141	118	123	162	154	129
[6]	Opioid-Related % of CSB Removals	14.6%	15.9%	18.6%	22.4%	25.7%	26.8%	30.6%	26.8%	26.5%	25 0%	31.3%	30.0%
[7]	Abuse, Dependency, Neglect Cases	1,276	1,207	1,025	980	915	858	805	832	843	915	1,062	1,022
[8]	Opioid-Related Abuse, Dependency, Neglect Cases	186	192	191	219	235	230	246	223	223	229	332	307
[9]	Total Opioid-Related Juvenile Cases	335	324	349	392	377	366	388	341	346	391	486	436
[10]	Total Juvenile Cases	12,718	11,835	10,377	9,803	8,516	7,444	7,343	6,914	6,565	6,964	7,137	6,670
[11]	**Opioid-Related % of Juvenile Cases**	**2.6%**	**2.7%**	**3.4%**	**4.0%**	**4.4%**	**4.9%**	**5.3%**	**4.9%**	**5.3%**	**5.6%**	**6.8%**	**6.5%**

Sources & Notes:
[1]=Panel C3[27].
[2]=Panel C1[27].
[3]=[1]/[2] in 2014-2016. All other years are trended based on Panel D[1].
[4]=Panel B[1].
[5]=[3]*[4].
[6]=Appendix III.E.2, Panel A[1].
[7]=Panel B[2].
[8]=[6]*[7].
[9]=([5]+[8]).
[10]=Panel B[4].
[11]=[9]/[10].

APPENDIX III.F.2

Opioid-Related Percent of Juvenile Court Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL B - JUVENILE CASES BY TYPE													
[1]	Delinquency and Unruly Cases	6,381	6,067	5,595	4,973	4,150	3,527	3,465	2,965	2,850	2,953	2,944	2,476
[2]	Abuse, Dependency, Neglect Cases	1,276	1,207	1,025	980	915	858	805	832	843	915	1,062	1,022
[3]	Other Cases (Traffic, Custody, etc.)	5,061	4,561	3,757	3,850	3,451	3,059	3,073	3,117	2,872	3,096	3,131	3,172
[4]	Total Juvenile Cases	12,718	11,835	10,377	9,803	8,516	7,444	7,343	6,914	6,565	6,964	7,137	6,670

Sources & Notes:

[1]-[3]: 2016 Annual Report, Summit Court of Common Pleas Juvenile Division at 7 (SUMMIT_001520288-319 at 294); 2017 Annual Report, Summit Court of Common Pleas Juvenile Division at 7 (SUMMIT_001520474-505 at 480).

[4]=Σ[1:3].

APPENDIX III.F.2
Opioid-Related Percent of Juvenile Court Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C1 - DELINQUENCY AND UNRULY CHARGES BY OFFENSE TYPE													
[1]	Aggravated Assault									30	19	28	
[2]	All Other Offenses									2,954	3,364	3,220	
[3]	Arson									N/A	N/A	N/A	
[4]	Burglary									100	139	177	
[5]	Curfew/Loitering/Vagrancy									N/A	1	1	
[6]	Disorderly Conduct									467	158	340	
[7]	Driving Under the Influence									N/A	N/A	N/A	
[8]	Drug Crimes									169	271	251	
[9]	Drunkenness									N/A	N/A	N/A	
[10]	Embezzlement									N/A	N/A	N/A	
[11]	Family and Children									N/A	N/A	N/A	
[12]	Forcible Rape									N/A	N/A	N/A	
[13]	Forgery and Fraud									N/A	N/A	N/A	
[14]	Gambling Offenses									N/A	N/A	N/A	
[15]	Human Trafficking									N/A	N/A	N/A	
[16]	Larceny-theft									329	502	435	
[17]	Liquor Laws									N/A	N/A	N/A	
[18]	Motor Vehicle Theft									N/A	N/A	N/A	
[19]	Murder									N/A	N/A	N/A	
[20]	Other Assaults									N/A	N/A	N/A	
[21]	Prostitution									N/A	N/A	N/A	
[22]	Robbery									N/A	N/A	N/A	
[23]	Sex Offenses									N/A	N/A	N/A	
[24]	Stolen Property									50	96	90	
[25]	Vandalism									N/A	N/A	N/A	
[26]	Weapons									N/A	18	35	
[27]	Total Delinquency and Unruly Charges									4,099	4,568	4,577	

Sources & Notes:

[1]-[26]: 2016 Annual Report, Summit Court of Common Pleas Juvenile Division at 9 (SUMMIT_001520288-319 at 296); 2015 Annual Report, Summit Court of Common Pleas Juvenile Division at 9 (SUMMIT_001520256-287 at 264).

[27]=Σ[1:26].

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APPENDIX III.F.2
Opioid-Related Percent of Juvenile Court Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C2 - DRUG-RELATED DELINQUENCY AND UNRULY CHARGES BY OFFENSE TYPE													
[1]	Aggravated Assault									1	1	1	
[2]	All Other Offenses									206	235	225	
[3]	Arson									N/A	N/A	N/A	
[4]	Burglary									32	45	57	
[5]	Curfew/Loitering/Vagrancy									N/A	N/A	N/A	
[6]	Disorderly Conduct									N/A	N/A	N/A	
[7]	Driving Under the Influence									N/A	N/A	N/A	
[8]	Drug Crimes									169	271	251	
[9]	Drunkenness									N/A	N/A	N/A	
[10]	Embezzlement									N/A	N/A	N/A	
[11]	Family and Children									N/A	N/A	N/A	
[12]	Forcible Rape									N/A	N/A	N/A	
[13]	Forgery and Fraud									N/A	N/A	N/A	
[14]	Gambling Offenses									N/A	N/A	N/A	
[15]	Human Trafficking									N/A	N/A	N/A	
[16]	Larceny-theft									95	144	125	
[17]	Liquor Laws									N/A	N/A	N/A	
[18]	Motor Vehicle Theft									N/A	N/A	N/A	
[19]	Murder									N/A	N/A	N/A	
[20]	Other Assaults									N/A	N/A	N/A	
[21]	Prostitution									N/A	N/A	N/A	
[22]	Robbery									N/A	N/A	N/A	
[23]	Sex Offenses									N/A	N/A	N/A	
[24]	Stolen Property									6	12	11	
[25]	Vandalism									N/A	N/A	N/A	
[26]	Weapons									N/A	1	1	
[27]	Drug-Related Delinquency and Unruly Charges									510	708	671	

Sources & Notes:
[1:26]=Panel C1[1:26]*Appendix III.F.3, Panel A[1:26].
[27]=Σ[1:26].

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APPENDIX III.F.2
Opioid-Related Percent of Juvenile Court Activity -- Summit

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C3 - OPIOID-RELATED DELINQUENCY AND UNRULY CHARGES BY OFFENSE TYPE													
[1]	Aggravated Assault									0	0	0	
[2]	All Other Offenses									76	86	82	
[3]	Arson									N/A	N/A	N/A	
[4]	Burglary									12	16	21	
[5]	Curfew/Loitering/Vagrancy									N/A	N/A	N/A	
[6]	Disorderly Conduct									N/A	N/A	N/A	
[7]	Driving Under the Influence									N/A	N/A	N/A	
[8]	Drug Crimes									52	91	85	
[9]	Drunkenness									N/A	N/A	N/A	
[10]	Embezzlement									N/A	N/A	N/A	
[11]	Family and Children									N/A	N/A	N/A	
[12]	Forcible Rape									N/A	N/A	N/A	
[13]	Forgery and Fraud									N/A	N/A	N/A	
[14]	Gambling Offenses									N/A	N/A	N/A	
[15]	Human Trafficking									N/A	N/A	N/A	
[16]	Larceny-theft									35	53	46	
[17]	Liquor Laws									N/A	N/A	N/A	
[18]	Motor Vehicle Theft									N/A	N/A	N/A	
[19]	Murder									N/A	N/A	N/A	
[20]	Other Assaults									N/A	N/A	N/A	
[21]	Prostitution									N/A	N/A	N/A	
[22]	Robbery									N/A	N/A	N/A	
[23]	Sex Offenses									N/A	N/A	N/A	
[24]	Stolen Property									2	4	4	
[25]	Vandalism									N/A	N/A	N/A	
[26]	Weapons									N/A	0	0	
[27]	Opioid-Related Delinquency and Unruly Charges									176	251	239	

Sources & Notes:
[1:26]=Panel C2[1:26]*Appendix III.F.3, Panel B[1:26].
[27]=Σ[1:26].

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL D - OPIOID-RELATED % OF CRIME													
[1]	Opioid-Related % of Crimes	5.4%	5.0%	6.6%	8.0%	7.9%	9.0%	9.5%	9.2%	10.0%	11 5%	11.8%	11.8%

Sources & Notes:
[1]=Appendix III.C 2, Panel A[3]*Panel A[6].

APPENDIX III.F.3
Opioid-Related Percent of Juvenile Court Activity -- General

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - DRUG-RELATED % OF CRIMINAL OFFENSES													
[1]	Aggravated Assault	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
[2]	All Other Offenses	7.0%	7.0%	7 0%	7 0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7 0%	7.0%
[3]	Arson	1.3%	1.3%	1 3%	1 3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1 3%	1.3%
[4]	Burglary	32.3%	32.3%	32 3%	32 3%	32.3%	32.3%	32.3%	32.3%	32.3%	32.3%	32 3%	32.3%
[5]	Curfew/Loitering/Vagrancy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[6]	Disorderly Conduct	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[7]	Driving Under the Influence	3.5%	3.5%	3.5%	3 5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3 5%	3.5%
[8]	Drug Crimes	100.0%	100.0%	100 0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100 0%	100.0%
[9]	Drunkenness	8.3%	8.3%	8.3%	8 3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8 3%	8.3%
[10]	Embezzlement	8.8%	8.8%	8.8%	8 8%	8.8%	8.8%	8.8%	8.8%	8.8%	8.8%	8 8%	8.8%
[11]	Family and Children	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%
[12]	Forcible Rape	5.5%	5.5%	5.5%	5 5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5 5%	5.5%
[13]	Forgery and Fraud	32.2%	32.2%	32.2%	32 2%	32.2%	32.2%	32.2%	32.2%	32.2%	32.2%	32 2%	32.2%
[14]	Gambling Offenses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[15]	Human Trafficking	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
[16]	Larceny-theft	28.8%	28.8%	28.8%	28 8%	28.8%	28.8%	28.8%	28.8%	28.8%	28.8%	28 8%	28.8%
[17]	Liquor Laws	0.0%	0.0%	0.0%	0 0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0 0%
[18]	Motor Vehicle Theft	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%	24.1%
[19]	Murder	3.9%	3.9%	3 9%	3 9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3 9%	3.9%
[20]	Other Assaults	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
[21]	Prostitution	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%	51.1%
[22]	Robbery	29.5%	29.5%	29 5%	29 5%	29.5%	29.5%	29.5%	29.5%	29.5%	29.5%	29 5%	29.5%
[23]	Sex Offenses	0.9%	0.9%	0.9%	0 9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0 9%	0.9%
[24]	Stolen Property	12.2%	12.2%	12.2%	12 2%	12.2%	12.2%	12.2%	12.2%	12.2%	12.2%	12 2%	12.2%
[25]	Vandalism	2.8%	2.8%	2.8%	2 8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2 8%	2 8%
[26]	Weapons	3.0%	3.0%	3.0%	3 0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3 0%	3 0%

Sources & Notes:
[1]-[26]: Estimated % of each type of offense attributable to drugs. US DOJ National Drug Intelligence Center, "The Economic Impact of Illicit Drug Use on American Society" (2011), Table 1.7 (uses data from 2002 Survey Of Inmates In Local Jails (SILJ)).

APPENDIX III.F.3
Opioid-Related Percent of Juvenile Court Activity -- General

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL B - OPIOID % OF DRUG-RELATED CRIMES													
[1]	Aggravated Assault	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[2]	All Other Offenses	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[3]	Arson	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[4]	Burglary	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[5]	Curfew/Loitering/Vagrancy	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[6]	Disorderly Conduct	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[7]	Driving Under the Influence	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[8]	Drug Crimes	12.7%	12.7%	16 8%	22 5%	27.5%	28.3%	27.3%	28.9%	30.7%	33.5%	33 9%	36.6%
[9]	Drunkenness	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[10]	Embezzlement	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[11]	Family and Children	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[12]	Forcible Rape	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[13]	Forgery and Fraud	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[14]	Gambling Offenses	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[15]	Human Trafficking	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[16]	Larceny-theft	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[17]	Liquor Laws	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[18]	Motor Vehicle Theft	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[19]	Murder	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[20]	Other Assaults	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[21]	Prostitution	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[22]	Robbery	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[23]	Sex Offenses	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[24]	Stolen Property	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[25]	Vandalism	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
[26]	Weapons	24.5%	24.5%	32.1%	32.1%	33.3%	33.3%	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%

Sources & Notes:
[1]-[7] & [9]-[26]: See Panel C2[3].
[8]: See Panel C1[3].

APPENDIX III.F.3
Opioid-Related Percent of Juvenile Court Activity -- General

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL C1 - OPIOIDS % OF DRUG OFFENSES													
[1]	Count of Opioids Reported		8,899	10,824	15,074	19,703	20,231	23,079	26,859	30,895	37,177	53,113	46,059
[2]	Count of Substances Tested		70,075	64,421	67,039	71,739	71,388	84,673	92,970	100,741	111,076	156,804	125,917
[3]	**Opioids % of Drug Offenses**	**12.7%**	**12.7%**	**16.8%**	**22.5%**	**27.5%**	**28.3%**	**27.3%**	**28.9%**	**30.7%**	**33.5%**	**33.9%**	**36.6%**

Sources & Notes:

[1]-[2] Counts for drugs identified by Ohio forensic laboratories reporting to the National Forensic Laboratory Information System (NFLIS). U S. Drug Enforcement Administration, Diversion Control Division. 2007-2017. Table 2: State counts for the most frequently identified drugs. Retrieved from the NFLIS Public Resource Library (https://www.nflis.deadiversion.usdoj.gov/Resources/NFLISPublicResourceLibrary.aspx). 2006 is set equal to 2007 due to lack of data.

[3]=[1]/[2].

PANEL C2 - OPIOIDS % OF ILLICIT SUBSTANCE DISORDERS													
[1]	Population % with Illicit Substance Disorders	3.3%	3.3%	2 8%	2 8%	3.1%	3.1%	3.0%	3.0%				
[2]	Population % with Opioid Use Disorder	0.8%	0.8%	0 9%	0 9%	1.0%	1.0%	1.1%	1.1%				
[3]	**Opioid % of Illicit Substance Disorders**	**24.5%**	**24.5%**	**32.1%**	**32.1%**	**33.3%**	**33.3%**	**36.6%**	**36.6%**	**36.6%**	**36.6%**	**36.6%**	**36.6%**

Sources & Notes:

[1]-[2]: 2006-2013 estimated using Ohio response data from the National Survey on Drug Use and Health (NSDUH). State-level NSDUH data is reported as two year averages. 2014-2017 data set equal to 2013 due to changes in NSDUH definition of OUD.

[3]=[2]/[1].

Appendix III.G: Opioid-Related Percent of Medical Examiner Autopsies

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APPENDIX III.G.1
Opioid-Related Percent of Medical Examiner Autopsies - Cuyahoga

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF AUTOPSIES (Medical Examiner)													
[1]	Opioid-Related Overdose Cases	120	112	140	157	181	214	231	256	269	289	565	554
[2]	Total In-County Autopsies	1,325	1,320	1,163	1,059	1,059	1,004	1,072	1,033	1,103	1,233	1,489	1,443
[3]	**Opioid-Related % of Autopsies**	**9.1%**	**8.5%**	**12.0%**	**14.8%**	**17.1%**	**21.3%**	**21.5%**	**24.8%**	**24.4%**	**23.4%**	**37.9%**	**38.4%**

Sources & Notes:

[1]: Number of overdose cases where opioids are identified as a cause of death. Based on analysis of medical examiner overdose case data (CUYAH_000099975). Data does not include out-of-county autopsies.

[2]: Cuyahoga County Budget Plans: 2008 at VI-15; 2009 at VI-16; 2010 at VI-15; 2012-13 at VII-100; 2014-15 at VII-119; 2016-17 at 83; 2018-19 at 38.

[3]=[1]/[2].

APPENDIX III.G.1
Opioid-Related Percent of Medical Examiner Autopsies - Summit

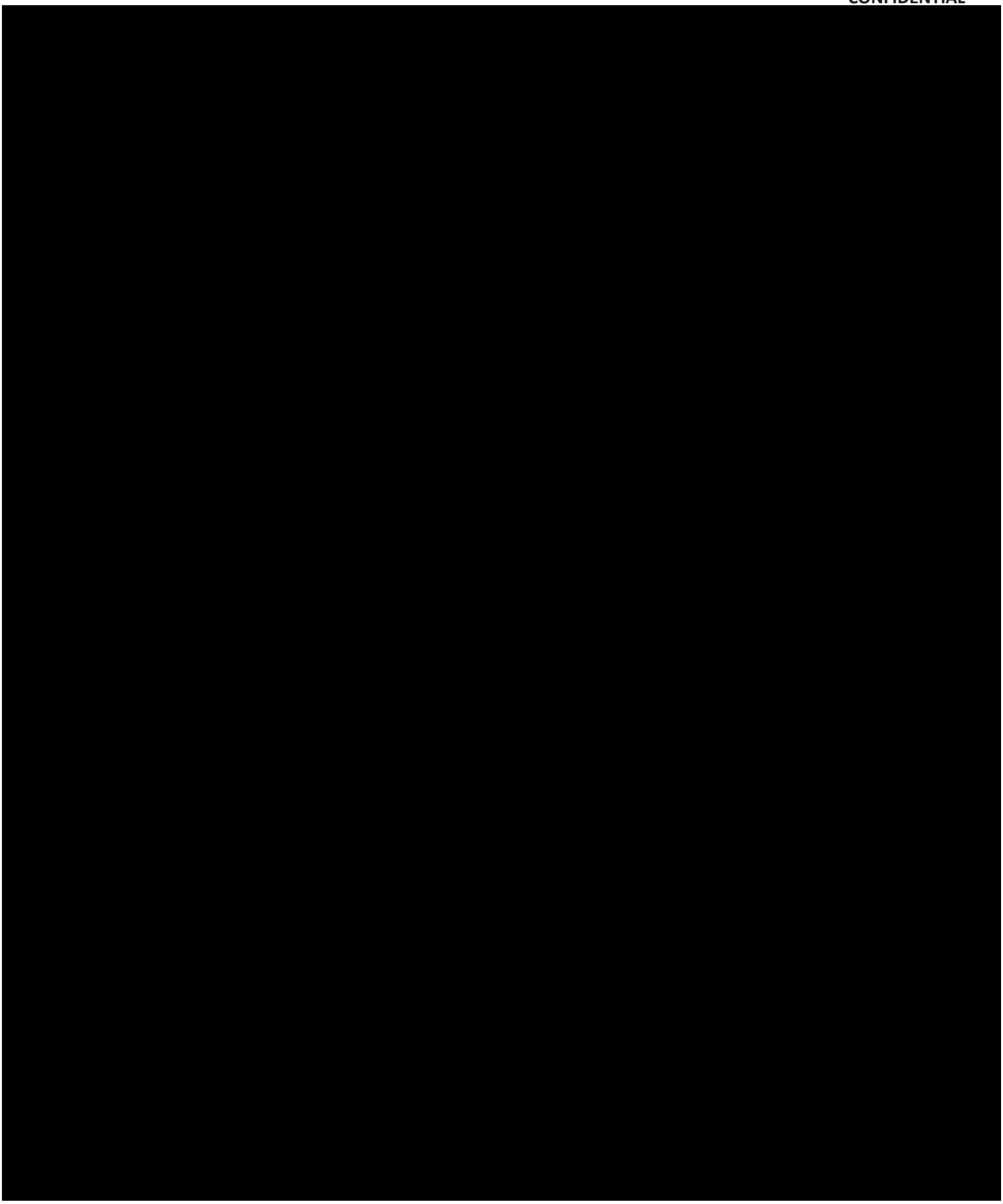
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PANEL A - OPIOID-RELATED % OF AUTOPSIES (Medical Examiner)													
[1]	Opioid-Related Overdose Autopsies	66	61	53	79	93	82	110	106	163	214	287	193
[2]	Total Autopsies	603	581	557	593	601	650	624	683	700	794	775	605
[3]	**Opioid-Related % of Autopsies**	**10.9%**	**10.5%**	**9.5%**	**13.3%**	**15.5%**	**12.6%**	**17.6%**	**15.5%**	**23.3%**	**27.0%**	**37.0%**	**31.9%**

Sources & Notes:
[1]: Total number of medical examiner autopsies where opioids are identified in the cause of death or where drugs or substance abuse are identified in the cause of death and opioids are found in toxicology results. Based on analysis of medical examiner data (SUMMIT_000087427).
[2]: Total number of medical examiner autopsies based on analysis of medical examiner data (SUMMIT_000087427).
[3]=[1]/[2].

PANEL B - IN-COUNTY AUTOPSIES % OF TOTAL AUTOPSIES													
[1]	In-County Autopsies Reported							483	502	522	590	705	
[2]	Out-of-County Autopsies Reported	71	84	71	120	143	167	139	181	187	212	71	0
[3]	Total Autopsies Reported							622	683	709	802	776	
[4]	Total Autopsies in Medical Examiner Data	603	581	557	593	601	650	624	683	700	794	775	605

Sources & Notes:
[1]: SUMMIT_000028305-308 at 305-306.
[2]: 2006-2015 and 2017 Summit County Medical Examiner Annual Reports at 1 (SUMMIT_000022439-3239 at 2443; 2514; 2587; 2660; 2734; 2807; 2881; 2955; 3027; 3100; 3172); 2012-2016 also reported in SUMMIT_000028305-308 at 305-306.
[3]=Σ[1:2].
[4]=Panel A[2].

Appendix III.H: Regression Estimation of the Relationship Between Shipments and Opioid-Related Mortality



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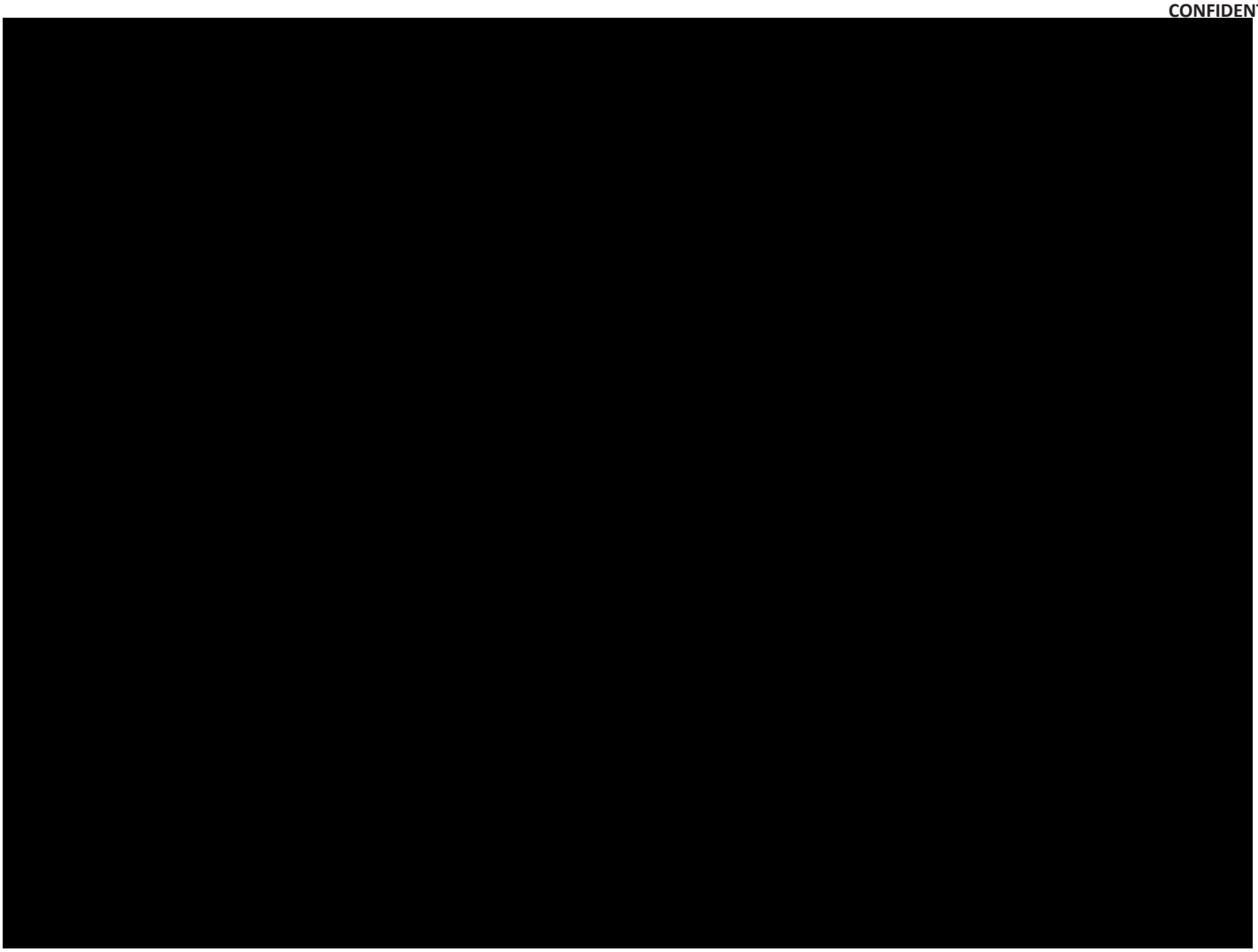
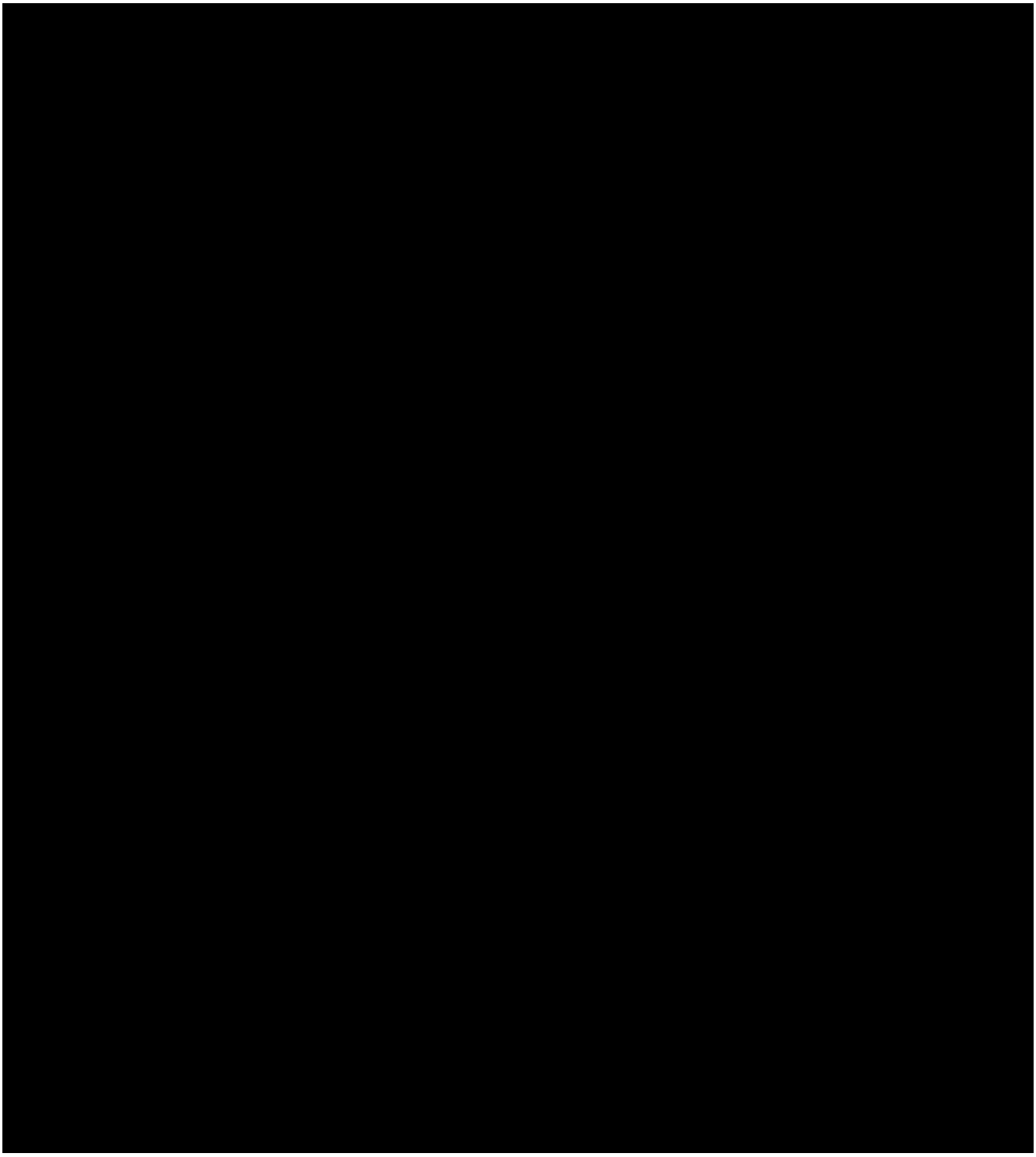
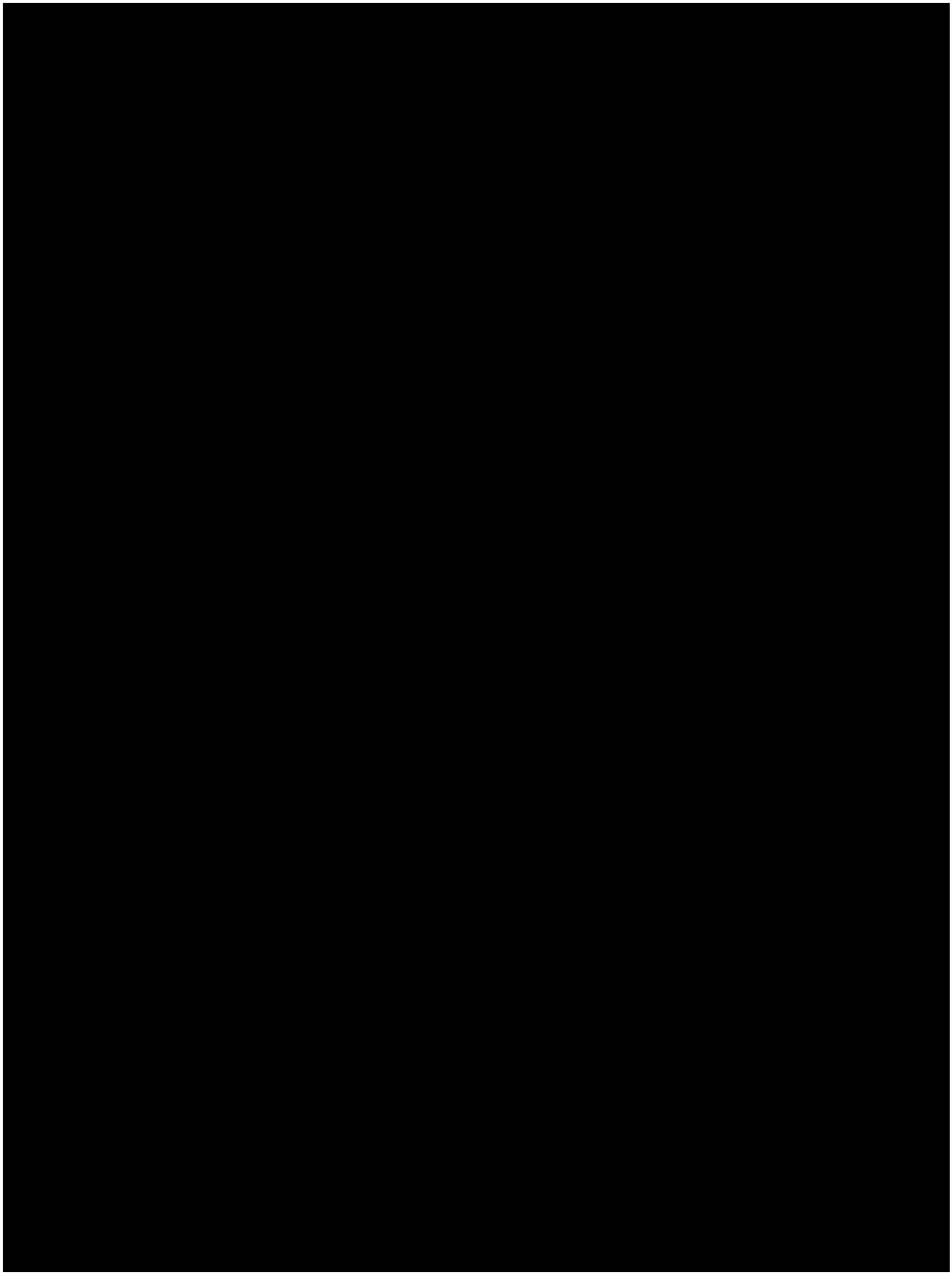
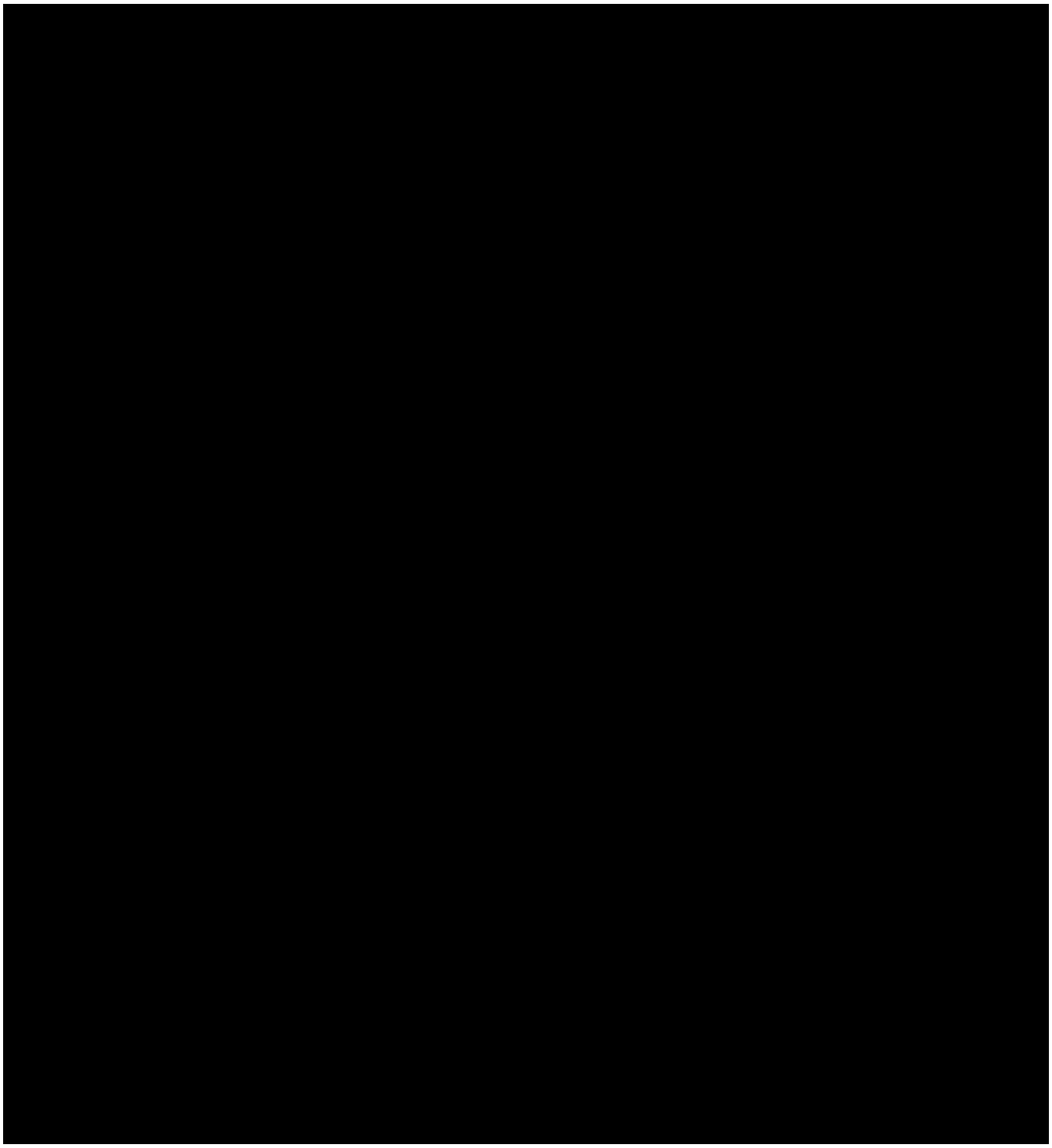


Appendix III.I: Share of Harms Due to All Shipments







Appendix III.J: Framework for Estimating Harms Due to Distributor Misconduct

1. As the Bellwether plaintiffs have alleged, the opioid epidemic and the need for increased services, "arose from the opioid manufacturers' deliberately deceptive marketing strategy to expand opioid use, together with the distributors' equally deliberate efforts to evade restrictions on opioid distribution."[1] While the defendants' misleading marketing contributed to the opioid epidemic, "the crisis was fueled and sustained by those involved in the supply chain of opioids, including manufacturers, distributors, and pharmacies . . . who failed to maintain effective controls over the distribution of prescription opioids, and who instead have actively sought to evade such controls . . . thereby exacerbating the oversupply of such drugs and fueling an illegal secondary market."[2]

2. Tables III.13 and III.14 report the share of harms due to defendants' misconduct that are based on estimates of the share of prescription opioid shipments attributable to misleading marketing reported by Prof. Rosenthal. While this estimate may reflect the harm that could have been avoided in the absence of marketing misconduct, some portion of the harm resulting from such shipments also could have been avoided had CSA registrants, such as defendant distributors, not acted improperly. I understand that all CSA registrants such as distributors of prescription opioids have legal obligations to monitor, identify and report shipments to regulatory authorities that may be unrelated to medical need and to prevent such shipments. The alleged failure to carry out these responsibilities thus contributed to the explosion of prescription opioid shipments that contributed to the opioid crisis documented by Prof. Gruber.

3. The estimates of the share of harms due to defendants' misconduct for Cuyahoga and Summit Counties reported in Tables III.16A-B do not attempt to uniquely attribute harm resulting from actions by any individual type of defendant. This does not reflect a problem with the underlying data or analysis but instead is the result of the fact that multiple parties are responsible for harms. For example, assume

[1] Cuyahoga Complaint, ¶3; Summit Complaint ¶3.
[2] Cuyahoga Complaint, ¶14; Summit Complaint, ¶14.

that 80% of harm can be attributed to manufacturer misconduct and 70% of that harm could have been avoided if distributors had acted properly. As an economic matter, manufacturers are appropriately held liable for at least the 10% of the harm that distributors could not have avoided. However, as discussed in the report, there is no unique or economically "correct" allocation of liability for the 70% of harm that could have avoided if each party had it met its legal obligations. Note that it is not necessarily the case that harm due to misconduct by CSA registrants is a subset of harm due to misleading marketing. Even in the absence of improper marketing, the failure of distributors and other CSA registrants to identify suspicious and excessive shipments can result in harm.

4. Nonetheless, the share of harm for which distributors can potentially be said to be liable can be estimated based on a variant of the framework used in Section VII. Specifically, the share of harm potentially attributable to distributors can be calculated by applying an estimate of the *share of excessive shipments that distributors failed to identify* (to the extent such a measure is available) instead of the estimate of the *share of shipments due to misleading marketing misconduct* in the Section VII framework. More specifically, the share of harm attributable to distributor misconduct can be measured as:

$$\begin{aligned} &Share\ of\ Harms\ Attributable\ to\ \textbf{Distributor}\ Misconduct \\ &= \ Share\ of\ Harms\ Attributable\ to\ Opioids \\ &\quad x\ Share\ of\ Opioid\ Harms\ Attributable\ to\ Opioid\ Shipments \\ &\quad x\ Share\ of Opioid\ Shipments\ Due\ to\ \textbf{Distributor}\ Misconduct \end{aligned}$$

5. That is, modifying the Section VII framework to address distributor misconduct requires only a modification of the last input, the "*Share of Opioid Shipments Due to Distributor Misconduct*," as the other two inputs are not specific to the attribution across the conduct of the multiple parties. This appendix presents an example of how this analysis can be applied if appropriate data become available

to estimate the share of prescription opioid shipments that reflect distributor misconduct. This example can be readily updated when appropriate estimates become available.

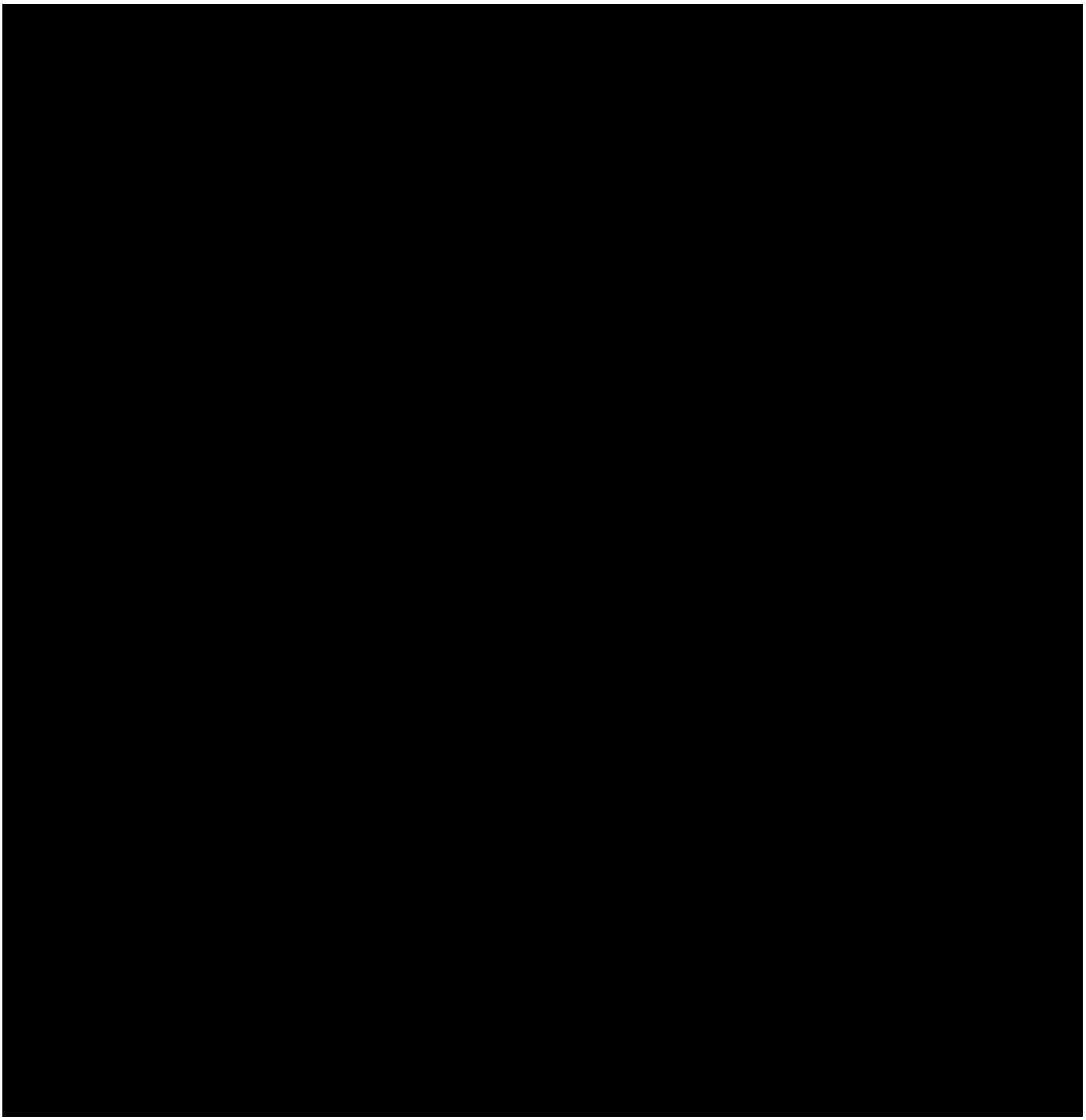
6. Table J.1 reports the data on the share of shipments for which the distributors are liable that have been provided to me by counsel and that I understand will be set forth in reports disclosed on April 15, 2019.

Table J.1: Percent of Shipments Attributable to Distributors' Misconduct

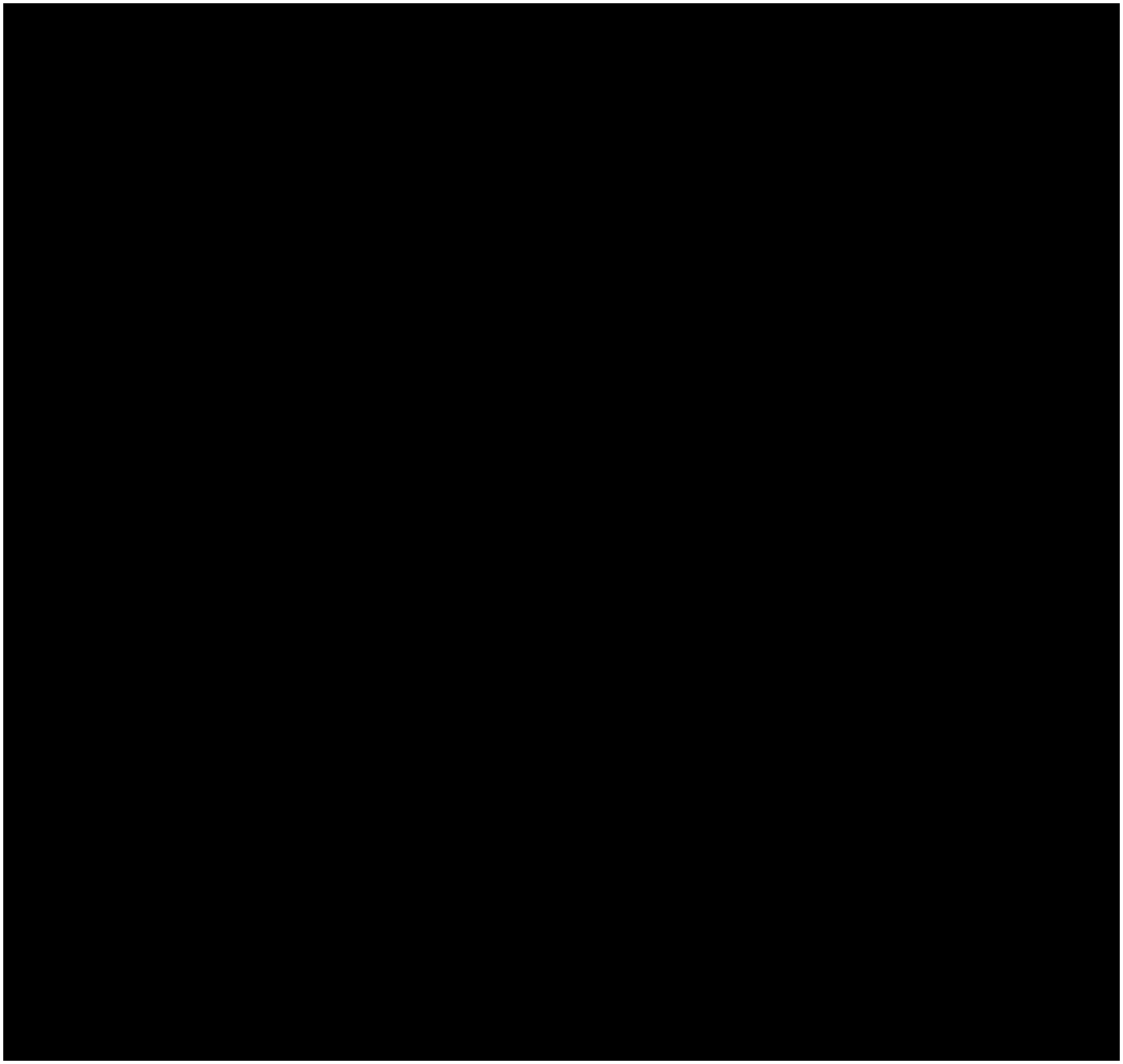
Year	Percent of Shipments Attributable to Distributors' Misconduct
1997	49.9%
1998	67.0%
1999	64.4%
2000	64.7%
2001	63.0%
2002	59.8%
2003	67.3%
2004	64.5%
2005	72.2%
2006	73.1%
2007	76.4%
2008	78.4%
2009	78.7%
2010	79.2%
2011	80.0%
2012	82.5%
2013	81.7%
2014	82.7%
2015	83.4%
2016	83.5%

These shares provide estimates of shipments of prescription opioids that would have been avoided in the absence of distributors' misconduct and can be used to estimate average shipments but-for distributor misconduct. Incorporating these estimates into the Approach 1 and Approach 2 analyses

(discussed in Section VI) then yields an estimate of the share of harms attributable to distributors' misconduct. Specifically, the calculation yields estimate of the product of the "*Share of Opioid Harms Attributable to Opioid Shipments*" and "*Share of Opioid Shipments Due to Distributor Misconduct*" in the equation above. Tables J.2 and J.3 below present these results.



7. The final step in the estimation is to combine these estimates with the "Share of Harm Attributable to Opioids" for the divisions identified in Cuyahoga and Summit counties, as described in Section IV. Tables J.4 and J.5 below report these results.



Appendix K: Estimate of Harms Due to Defendants' Misconduct from Indirect Shipments Regression

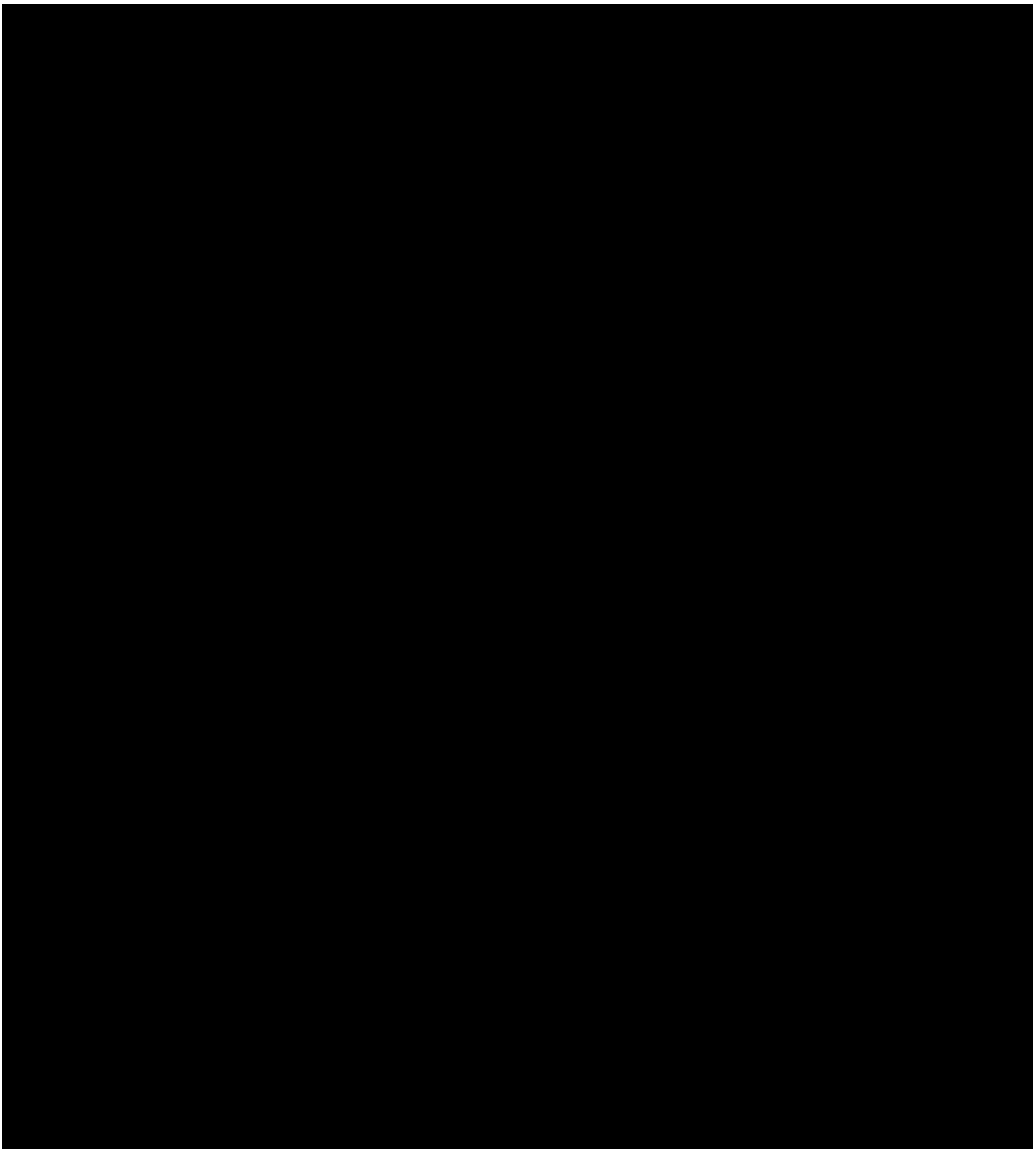
1. Tables III.13 and III.14 report the percentage of harm attributable to prescription opioid shipments that are due to the defendants' misconduct. This analysis incorporates the estimates from the share of prescription opioid shipments that were due to misleading marketing from the direct shipments regression method presented in the Rosenthal Report. Prof. Rosenthal also presents an alternative method to estimate the share of prescription opioids due to defendants' misconduct using an indirect shipments regression. Table K.1 below replicates this alternative estimate from the Rosenthal Report.

Table K.1: Estimate of Percent of Shipments Attributable to Defendants' Misconduct Using Rosenthal Indirect Method

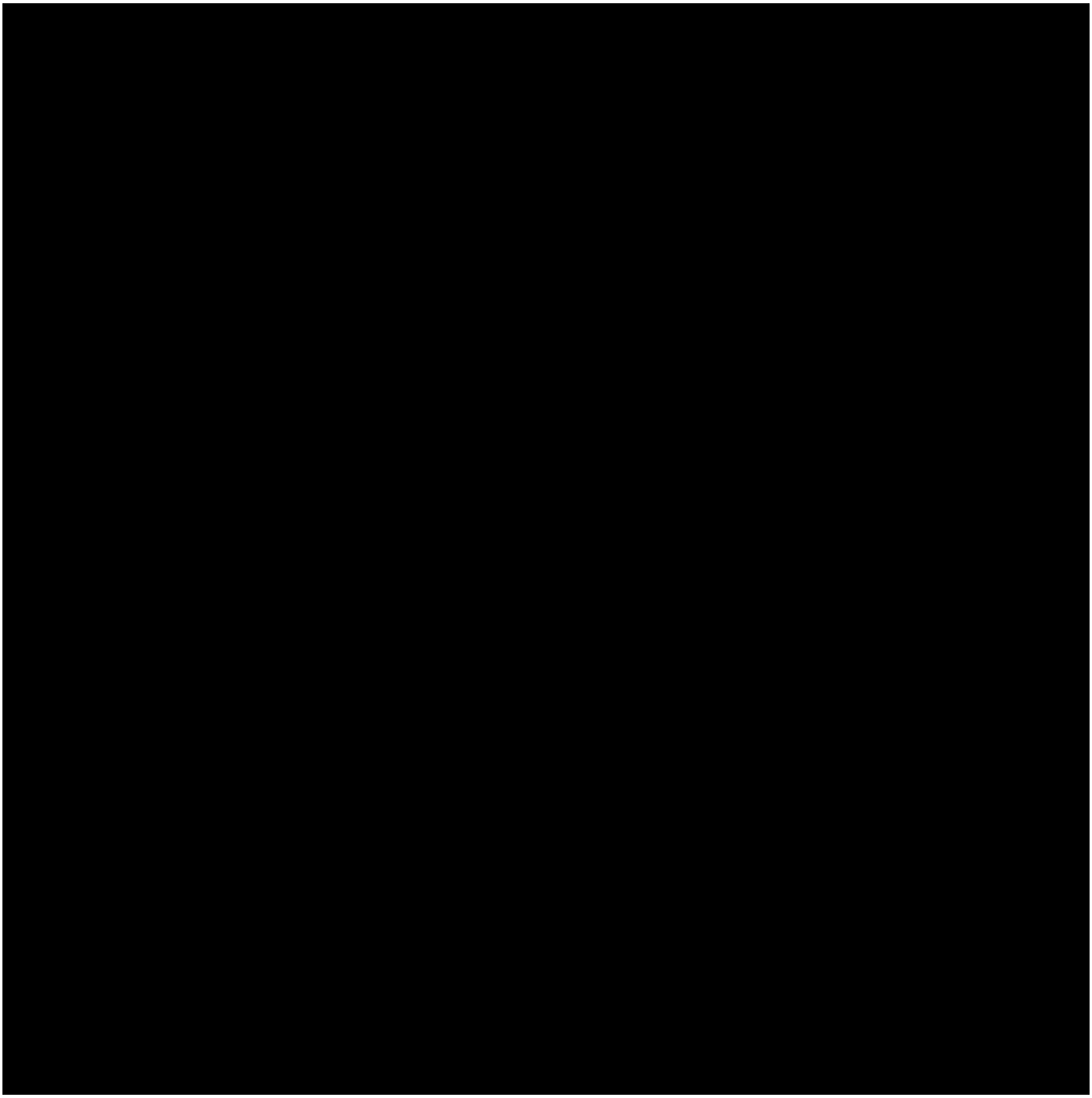
Year	Percent of Shipments Attributable to Defendants' Misconduct
1997	15.2%
1998	21.9%
1999	30.2%
2000	43.5%
2001	51.2%
2002	56.8%
2003	63.2%
2004	65.8%
2005	65.8%
2006	69.0%
2007	72.4%
2008	73.1%
2009	74.5%
2010	75.8%
2011	75.4%
2012	74.2%
2013	72.5%
2014	71.7%
2015	70.5%
2016	67.6%

Source: Rosenthal Report.

2. Tables K.2 and K.3 below present an alternative analysis of the share of harms attributable to defendants' misconduct by incorporating Prof. Rosenthal's indirect shipments regression method into Approach 1 and Approach 2.



3. The final step in the estimation is to combine these estimates above with the "Share of Harm Attributable to Opioids" for the divisions identified in Cuyahoga and Summit counties, as described in Section IV. Tables K.4 and K.5 below report these results.



Appendix III.L: Regression Estimation of the Relationship between Shipments and Crime

Change in Property Crime Offenses from 1995/96 to 2015/16

UCR Dataset - Counties over 100k with Pre-Period Crime

Ordinary Least Squares Regression

Robust Standard Errors

Number of obs = 417
Adjusted R-squared = 0.79

Variable	Mean	Coef.	Std. Err	t	P>|t|
Change in Property Crime 1995/96 to 2015/16	-2,114.52				
Avg. Shipments per Capita per Day (1997-2010)	1.46	286.49	75.34	3.80	.00
Property Crime Level in 1995/96	4,722.76	-.70	.03	-23.84	.00
Percent Male in 1995/96	.49	4,920.00	4,381.45	1.12	.26
Percent Under 15 in 1995/96	.22	4,297.69	2,920.84	1.47	.14
Percent 15 to 29 in 1995/96	.21	2,612.14	2,140.82	1.22	.22
Percent 30 to 44 in 1995/96	.24	5,284.91	3,193.96	1.65	.10
Percent 45 to 64 in 1995/96	.20	9,049.15	4,547.10	1.99	.05
Percent White in 1995/96	.84	-1,167.10	540.75	-2.16	.03
Percent Black in 1995/96	.12	-424.99	678.00	-.63	.53
Percent Hispanic in 1995/96	.08	-396.69	774.54	-.51	.61
Percent Less High School in 1995/96	.17	6,378.51	1,936.89	3.29	.00
Percent High School in 1995/96	.39	-108.97	1,143.81	-.10	.92
Percent Some College in 1995/96	.20	4,365.17	1,671.50	2.61	.01
Employment Ratio in 1995/96	.62	1,509.29	1,169.94	1.29	.20
Percent Unemployed in 1995/96	.05	2,472.95	2,016.23	1.23	.22
Median Household Income (Thousands) in 1995/96	54.14	-26.24	7.86	-3.34	.00
Percent Ag/M/Const/Util in 1995/96	.08	-1,401.11	1,220.40	-1.15	.25
Percent Manufacturing in 1995/96	.22	334.11	698.84	.48	.63
Percent Retail/Transportation in 1995/96	.24	284.34	889.08	.32	.75
Percent Professional in 1995/96	.19	845.76	815.33	1.04	.30
Poverty Rate in 1995/96	.12	176.29	2,100.98	.08	.93
Percent Urban in 1995/96	.79	694.66	339.83	2.04	.04
Census Population (Thousands) in 1995/96	402.61	-.08	.07	-1.27	.21
Change in Percent Male 1995/96 to 2015/16	.00	14,489.98	8,823.96	1.64	.10
Change in Percent Under 15 1995/96 to 2015/16	-.03	1,765.42	4,019.74	.44	.66
Change in Percent 15 to 29 1995/96 to 2015/16	.00	5,398.25	3,252.55	1.66	.10
Change in Percent 30 to 44 1995/96 to 2015/16	-.06	-3,353.04	3,684.66	-.91	.36
Change in Percent 45 to 64 1995/96 to 2015/16	.06	-2,435.54	4,336.46	-.56	.57
Change in Percent White 1995/96 to 2015/16	-.06	-1,282.99	1,710.38	-.75	.45
Change in Percent Black 1995/96 to 2015/16	.02	-986.56	2,020.31	-.49	.63
Change in Percent Hispanic 1995/96 to 2015/16	.06	-4,181.67	1,117.32	-3.74	.00
Change in Percent Less High School 1995/96 to 2015/16	-.07	7,734.26	2,774.37	2.79	.01
Change in Percent High School 1995/96 to 2015/16	-.03	5,345.81	2,067.80	2.59	.01
Change in Percent Some College 1995/96 to 2015/16	.03	4,804.39	3,070.86	1.56	.12
Change in Employment Ratio 1995/96 to 2015/16	-.04	2,276.85	1,576.64	1.44	.15
Change in Percent Unemployed 1995/96 to 2015/16	.00	11,992.88	4,383.58	2.74	.01
Change in Median Household Income (Thousands) 1995/96 to 2015/16	-.59	32.09	11.27	2.85	.00
Change in Percent Ag/M/Const/Util 1995/96 to 2015/16	-.01	-964.85	1,456.34	-.66	.51
Change in Percent Manufacturing 1995/96 to 2015/16	-.13	84.37	1,132.71	.07	.94
Change in Percent Retail/Transportation 1995/96 to 2015/16	-.01	-1,808.61	1,285.76	-1.41	.16
Change in Percent Professional 1995/96 to 2015/16	.04	905.34	821.70	1.10	.27
Change in Poverty Rate 1995/96 to 2015/16	.03	4,754.23	2,535.23	1.88	.06
Change in Percent Urban 1995/96 to 2015/16	.04	-679.89	872.48	-.78	.44
Change in Census Population (Thousands) 1995/96 to 2015/16	93.38	.15	.30	.50	.61
Constant		-6,713.65	2,689.14	-2.50	.01

Source: UCR Crime data; U.S. Census data; ARCOs

Change in Violent Crime Offenses from 1995/96 to 2015/16

UCR Dataset - Counties over 100k with Pre-Period Crime

Ordinary Least Squares Regression

Robust Standard Errors

Number of obs = 417
Adjusted R-squared = 0.78

Variable	Mean	Coef.	Std. Err	t	P>|t|
Change in Violent Crime 1995/96 to 2015/16	-212.42				
Avg. Shipments per Capita per Day (1997-2010)	1.46	48.79	20.35	2.40	.02
Violent Crime Level in 1995/96	556.39	-.65	.04	-15.14	.00
Percent Male in 1995/96	.49	-584.23	893.58	-.65	.51
Percent Under 15 in 1995/96	.22	879.00	515.69	1.70	.09
Percent 15 to 29 in 1995/96	.21	126.52	507.16	.25	.80
Percent 30 to 44 in 1995/96	.24	831.13	580.37	1.43	.15
Percent 45 to 64 in 1995/96	.20	149.29	1,036.85	.14	.89
Percent White in 1995/96	.84	-176.47	77.41	-2.28	.02
Percent Black in 1995/96	.12	-94.99	124.44	-.76	.45
Percent Hispanic in 1995/96	.08	-145.40	138.17	-1.05	.29
Percent Less High School in 1995/96	.17	795.90	391.28	2.03	.04
Percent High School in 1995/96	.39	421.95	290.33	1.45	.15
Percent Some College in 1995/96	.20	509.27	367.38	1.39	.17
Employment Ratio in 1995/96	.62	98.52	245.26	.40	.69
Percent Unemployed in 1995/96	.05	364.55	485.39	.75	.45
Median Household Income (Thousands) in 1995/96	54.14	-1.59	1.59	-1.00	.32
Percent Ag/M/Const/Util in 1995/96	.08	-167.67	311.26	-.54	.59
Percent Manufacturing in 1995/96	.22	-67.88	156.48	-.43	.66
Percent Retail/Transportation in 1995/96	.24	-388.23	246.28	-1.58	.12
Percent Professional in 1995/96	.19	-8.14	190.49	-.04	.97
Poverty Rate in 1995/96	.12	903.54	532.99	1.70	.09
Percent Urban in 1995/96	.79	-3.59	73.68	-.05	.96
Census Population (Thousands) in 1995/96	402.61	.00	.01	.31	.76
Change in Percent Male 1995/96 to 2015/16	.00	348.68	2,273.33	.15	.88
Change in Percent Under 15 1995/96 to 2015/16	-.03	1,117.91	862.28	1.30	.20
Change in Percent 15 to 29 1995/96 to 2015/16	.00	1,171.13	743.50	1.58	.12
Change in Percent 30 to 44 1995/96 to 2015/16	-.06	-158.57	823.28	-.19	.85
Change in Percent 45 to 64 1995/96 to 2015/16	.06	238.97	960.86	.25	.80
Change in Percent White 1995/96 to 2015/16	-.06	-420.86	357.38	-1.18	.24
Change in Percent Black 1995/96 to 2015/16	.02	84.40	476.72	.18	.86
Change in Percent Hispanic 1995/96 to 2015/16	.06	-104.85	241.42	-.43	.66
Change in Percent Less High School 1995/96 to 2015/16	-.07	582.75	640.43	.91	.36
Change in Percent High School 1995/96 to 2015/16	-.03	441.85	545.70	.81	.42
Change in Percent Some College 1995/96 to 2015/16	.03	-853.18	569.62	-1.50	.14
Change in Employment Ratio 1995/96 to 2015/16	-.04	100.17	360.77	.28	.78
Change in Percent Unemployed 1995/96 to 2015/16	.00	2,138.88	1,085.12	1.97	.05
Change in Median Household Income (Thousands) 1995/96 to 2015/16	-.59	.06	2.28	.03	.98
Change in Percent Ag/M/Const/Util 1995/96 to 2015/16	-.01	71.07	409.72	.17	.86
Change in Percent Manufacturing 1995/96 to 2015/16	-.13	225.48	239.29	.94	.35
Change in Percent Retail/Transportation 1995/96 to 2015/16	-.01	-358.31	319.38	-1.12	.26
Change in Percent Professional 1995/96 to 2015/16	.04	402.05	218.53	1.84	.07
Change in Poverty Rate 1995/96 to 2015/16	.03	180.54	560.91	.32	.75
Change in Percent Urban 1995/96 to 2015/16	.04	-339.26	158.97	-2.13	.03
Change in Census Population (Thousands) 1995/96 to 2015/16	93.38	-.10	.07	-1.43	.15
Constant		-177.99	542.79	-.33	.74

Source: UCR Crime data; U.S. Census data; ARCOs